THE NURSES
TEXT BOOK SERIES

MATERIA MEDICA AND THERAPEUTICS

A TEXT-BOOK FOR NURSES

BY

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PREFACE TO THE SECOND EDITION.

The demand for a second edition of this book so soon after its original publication is a source of gratification to the author. It is a pleasure to feel that success has followed this effort to give the nursing profession a practical text-book on Materia Medica, which is also sufficiently comprehensive.

The aim of the work is to present the use of drugs from a scientific basis in such a way as to appeal to the nurse's interest. An effort has been made to give only the important and practical points which form a foundation for an intelligent handling of drugs, but not for prescribing them. The classification by systems seems the most practical from the nurse's point of view. In Toxicology only the striking symptoms of poisoning are given, because they can be more easily remembered than detailed descriptions. First aid treatments are emphasized.

The study of Materia Medica needs to be supplemented by experiments, demonstrations, and observations in the wards. The number of experiments suitable for hospital class work is very limited. In the discussion of any drug it is important that the forms in which it is used as a medicine should be shown before

the class unless they are very well known. Detailed descriptions of the physical properties of drugs have in many cases been omitted, as familiarity with their appearance can only be gained by actually seeing them.

An effort has been made to give a broader interest in this field than is obtained in the hospital and the sick-room. A nurse should have some conception of the world-wide drug industry that she may appreciate the work of the many trained scientific men engaged in it, and on the other hand, that she may be cognizant of the evils of patent medicines and nostrums.

No drugs described in the first edition have been omitted in the second. The oil of chenopodium is included as an anthelmintic and the description of nitrous oxide as an anesthetic has been elaborated. Numerous amplifications and minor changes have been made to clarify the text. A diagram has been added to the portion of the chapter on solutions which explains the method of making weak from strong solutions, and this part has been rewritten on the basis of the diagram.

The author is again indebted to Dr. Cary Eggleston, of Cornell Medical School, New York City, for his advice and suggestions in this edition.

L. A. P

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PART I.

PHARMACY.

CHAPTER I.

WEIGHTS AND MEASURES.

In the United States, unfortunately, there are in use several systems of weights and measures in handling drugs—the apothecaries', avoirdupois, household, and metric. The apothecaries' and avoirdupois systems, which have their origin and legal standards in England, have been in most common use, but are gradually being replaced by the metric system, the French system of measure. Household measures, cups, spoons, and the like, frequently have to be used in the home.

In the work-room of every pharmacy there are sets of apothecaries' and of metric weights and measures. These are used in measuring drugs for prescriptions and in making up stock preparations, such as liniments, spirits, and solutions. On the outside counter of the store, however, all drugs sold in bulk are weighed according to the avoirdupois system.

METRIC SYSTEM.

Table of Weights.

1 gramme (Gm.)	=	10 decigrammes (dg.)
	=	100 centigrammes (cg.)
	=	1000 milligrammes (mg.)
10 grammes	=	1 dekagramme (Dg.)
100 grammes	=	1 hectogramme (Hg.)
1000 grammes	=	1 kilogramme (Kg.)

The dekagramme and hectogramme are not much used, large quantities being expressed as 15 Gm. instead of 1 Dg. and 5 Gm. The ending -me, especially in gramme, should always be used in spelling these words, because, in writing, the words grain and gram are easily confused. The prefixes of the denominations below a gramme are duplicated in our system of money and a comparison will help in remembering the names and their relation.

1 dollar	=	10 dimes	1 gramme	=	10 decigrammes
	=	100 cents		=	100 centigrammes
	=	1000 mills		=	1000 milligrammes

The table of weights below one gramme may be written as follows:

1 gramme	=	1.000 gramme
1 decigramme	=	0.1 "
1 centigramme	=	0.01 "
1 milligramme	=	0.001 "

It is then seen that each decimal place in the gramme represents one of the lower denominations, *e. g.*, the first place is taken by decigrammes as they are one-tenth of a gramme and 2.3 grammes may be read 2

grammes and 3 decigrammes or 23 decigrammes. 4.25 grammes may be read 4 grammes, 2 decigrammes, and 5 centigrammes, or 425 centigrammes. Therefore, converting a figure in the metric system from one denomination to another is simply a matter of moving the decimal point, which is equivalent to multiplying or dividing by 10, 100, or 1000. Move it to the left if converting to a larger denomination, to the right if to a smaller. Move it one place if the denomination is larger or smaller by 10, two places if by 100, and three places if by 1000.

If it is known that a quantity is expressed in the metric system the denominations are often understood without being written. 4.5 in the metric system is always grammes, 0.008 in eight-thousandths of a gramme, 0.8 is eight-tenths of a gramme. The denominations, centigramme and decigramme, are not commonly used, a quantity being expressed as 500 mg. or 0.5 Gm. instead of 5 dg., and 20 mg. or 0.02 Gm. instead of 2 cg. All decimal fractions are written with a zero at the left of the decimal point.

Problems.

1. Convert the following to grammes by changing the decimal point:
   4000 mg.; 450 dg.; 64 mg.; 9 dg.
2. Convert the following to grammes:
   8 mg.; 24 dg.; 6 dg.; 24 mg.
3. Convert the following to milligrammes:
   4 Gm.; 5 dg.; 44 cg.; 12 Gm.
4. Add the following and express the sum in grammes:
   4 Gm.; 6 dg.; 8 mg.; 12 mg.

Solution	4 Gm.	= 4.000
	6 dg.	= 0.6
	8 mg.	= 0.008
	12 mg.	= 0.012
		4.620

5. Add and express sum in grammes:
   (1) 8 mg.; 6 dg.; 4 Gm.; 5 cg.
   (2) 20 dg.; 3.2 Gm.; 6 mg.; 45 mg.
6. Add and express sum in milligrammes:
   (1) 5 mg.; 9 dg.; 6 Gm.; 7 cg.
   (2) 64 mg.; 23 Gm.; 8 dg.; 5 mg.
7. The dose of morphine sulphate is 15 mg. How many doses could be given from 1 gramme?
8. The dose of strychnine sulphate is 0.001 Gm. How many mg. in 4 doses?
9. The dose of hexamethylenamine (urotropin) is 250 mg. How many grammes would you need for 4 doses?
10. The dose of aspirin is 3 dg. How many doses in 3 grammes?

Tables of Volume and Length.—These are on the same basis as the table of weights, and can be easily written out from that table by substituting in the names of the different measures liter for gramme for the table of volume and meter for gramme for the table of length. For example, the table of volume is 1 liter = 10 deciliters, 100 centiliters, and so on; the table of length 1 meter = 10 decimeters, 100 centimeters, and so on. Pharmacists are sometimes called upon to use linear measure in making plasters of prescribed size; a nurse probably would never use it. In the table of volume the liter and cubic centimeter are practically the only measures in common use. 1 liter equals 1000 milliliters and 1 milliliter is a quantity of water which at 4° C. would occupy 1 cubic centimeter of space. Therefore the term milliliter is synonomous with that of cubic centimeter, and the latter term is generally used. The common equivalents are as follows:

1000 cubic centimeters (Cc.)	= 1 liter (L.)
1 Cc. at 4° C. weighs	1 gramme

Therefore 1000 Cc. or 1 L. at 4° C. weighs 1000 Gm. or 1 Kg.

PROBLEMS.

1. How many Cc. of water would you measure out to get the following:
    60 Gm.; 9 Kg.; 9 dg.; 60 mg.
2. How much would the following quantities weigh:
    6 L.; 4.6 Cc.; 0.4 Cc.; 45 Cc.?
3. How many Cc. in 2.6 L?
4. The dose of atropine sulphate is 0.4 mg. What fraction of a gramme is needed to make 30 Cc. of a solution in which 1 Cc. would contain the dose?
5. The dose of tincture of opium is 0.5 Cc. 10 Cc. of the tincture contain 1 Gm. of opium. 12 per cent. of opium is morphine. How many milligrammes of morphine in one dose of the tincture?

APOTHECARIES' SYSTEM.

Table of Weight.

20 grains (gr.)	= 1 scruple (℈)[1]		
3 scruples	= 1 dram (ʒ)	=	60 grains
8 drams	= 1 ounce (℥)	=	480 "
12 ounces	= 1 pound (℔)	=	5760 "

The scruple is seldom used, all quantities less than a dram being expressed in grains. The quantity $\frac{1}{2}$ is expressed by the symbol ss. When the symbols are used the quantity is expressed in Roman numerals and written after the symbol, *e. g.*, 2 grains is written gr. ij; 5 drams, ʒv; a half of a grain, gr. ss.

[1] About the time of Christ signs were in common use to express quantities. The apothecaries' signs ℈, ʒ, ℥, used at the present time, are believed to have originated from these, and they differ only slightly from the ones which in those early times designated about the same quantities. The abbreviations for pint (O) and for gallon (C) (see table of liquid measure) are derived from the Latin words octarius, one-eighth of a gallon, and congius, a gallon.

Problems.

1. How many grains in ℥iv; ʒv; ℥iiss?
2. Salt ℥j will make how many quarts of saline solution (gr. xc to 1 qt.)?
3. One Seidlitz powder contains sodium bicarbonate gr. xl. How many drams of sodium bicarbonate in six powders?
4. How many drams of salt would you need to make 4 qts. of saline solution (gr. xc to 1 qt.)?
5. How many ounces of mucol are needed to make 2 qts. of solution (gr. lx to Oj)?

Table of Liquid Measure.

60 minims (♏)	= 1 fluidram	(fʒ)			
8 fluidrams	= 1 fluidounce	(f℥)	=	480 minims	
16 fluidounces	= 1 pint	(O)	=	7,680	"
2 pints	= 1 quart	(qt.)	=	15,000	"
4 quarts	= 1 gallon	(C)			

These symbols and quantities are written like those of weights: 7 minims = ♏vij, 5 fluidounces = f℥v. In common practice the symbols for a *liquid* ounce and dram are the same as for an ounce and dram by weight, it being understood that the substance is a liquid. For example, 5 fluidounces of alcohol are expressed ℥v.

Problems.

1. The dose of a solution is ♏xxx. This dose contains gr. $\frac{1}{30}$ of strychnine. How much of the drug in f℥j of the solution?
2. A solution of hexamethylenamine is labelled f℥ss = gr. vj. How many drams of the solution would you use to give gr. ix of the drug?
3. Morphine gr. vj is contained in f℥j of a solution. How much morphine in ♏x?
4. How many ounces of salt solution (gr. xc to 1 qt.) could be made with gr. xxx of salt?
5. ʒij of a solution contain gr. j of cocaine. How much cocaine is given when a doctor orders ♏x of the solution.

AVOIRDUPOIS SYSTEM OF WEIGHTS.

$437\frac{1}{2}$ grains = 1 ounce (oz.)
16 ounces = 1 pound (℔) = 7000 grains

Two points of difference should be noted between this and the apothecaries' system of weights: (1) the smaller number of grains in the ounce, and (2) the greater number of ounces in the pound.

PROBLEMS.

(The weighing in the following is done by apothecaries' weights; the drugs bought in bulk are weighed according to the avoirdupois system.)

1. A pound of salt will make how many quarts of saline (gr. xc to 1 qt.)?
2. Four ounces of sodium bicarbonate will make how many Seidlitz powders (gr. xl in each powder)?
3. If the pharmacy nurse buys 1 oz. of trional how many powders of gr. x can she make?

HOUSEHOLD MEASURES.

60 drops (gtt.)	= 1 teaspoonful (t.).
4 teaspoonfuls	= 1 tablespoonful (T).
2 tablespoonfuls	= 1 fluidounce.
2 fluidounces	= 1 wineglass.
6 fluidounces	= 1 teacup.
8 fluidounces	= 1 glassful.

Drops, teaspoons, tablespoons, and cups vary so much in size that this system should never be used if it can be avoided. A drop of water at ordinary temperature is considered equivalent to a minim, and both approximately weigh 1 grain. The difference between a ninim and a drop can be easily demon-

strated by expelling 10 minims of different fluids, drop by drop, from a graduated minim dropper. It will be seen that 10 minims make about 20 drops of water, about 40 drops of alcohol, and less than 20 drops of heavy oils. Therefore, if a doctor orders 10 minims of an alcoholic preparation, like a tincture, and 10 drops are given, the patient gets only a portion of the dose.

Problems.

1. State how you would measure quantities for the following orders using household measures:

(*a*) Douche, ʒj to a pint.
(*b*) Injection, ℥ij to ℥iv.
(*c*) Nutritive enema:

Malted milk,	℥ss
Somatose,	ʒj
Water,	℥iv
Sodium bicarb.,	gr. xx

(*d*) Enema:

White of egg,	
Glycerin,	℥ij
Oil of turpentine,	ʒij
Water,	Oj

APPROXIMATE EQUIVALENTS.

1 gramme	= gr. xv
1 cubic centimeter	= ♏xv
1 grain	= 0.064 Gm. or 64 mg.
1 fluidram	= 4 Cc.
1 dram	= 4 Gm.
1 fluidounce	= 30 Cc.
1 ounce	= 30 Gm.
1 quart	= 1 L.

The equivalents for fractions of a grain are obtained by considering 1 grain equal to 60 milligrammes. Then

$\frac{1}{60}$ of a grain equals 1 milligramme and the other fractions in common use can be easily reckoned. Any measure between 1 and 15 grains or minims is expressed in a decimal fraction of a gramme or cubic centimeter. The approximate equivalents in common use from 1 to 15 grains are expressed in *round numbers* as in the table below. Those for minims in cubic centimeters are the same as grains in terms of grammes.

1 grain	= 0.064 gramme.	5 grains	= 0.3 gramme.
2 "	= 0.1 "	7, 7½, 8 "	= 0.5 "
3 "	= 0.2 "	10 "	= 0.6 "
4 "	= 0.25 "	15 "	= 1.0 "

Problems.

1. Express the following in grains:
   4 Gm.; 24 mg.; 0.6 Gm.; 5 mg.
2. Give the equivalents in the apothecaries' system:
   3 t.; 12 Cc.; 2 Gm.; 0.6 Cc.
3. If only a Cc. measure were available how would you obtain the following:
   Oj; f℥v; 1 T.; fʒiij; a glassful; ½ L.; 10 Gm.?
4. With household measures how would you obtain the following:
   ʒiv; 2 Gm.; f℥ss; ♏xx; 1 L.; 20 Cc.; ℥j?
5. With metric weights how would you weigh the following:
   gr. xxx; ℥ss; ʒij; gr. $\frac{1}{20}$?

USE AND CARE OF MEASURING APPARATUS.

All weights should be kept in a closed box. An accumulation of dust will make them inaccurate, especially the small ones. Small weights should be handled with forceps only. No weights should be so scrupulously cleaned as to polish off the lacquer or metal and thus reduce their weight. When not in use balances ought to be covered, and at all times kept clean.

Balances are gauged to weigh quantities within certain limits, as from 0.1 to 10 Gm., and are not accurate beyond those limits. Before using a balance make sure that it is in equilibrium, and that it is not in a draught of air. The weights should be placed on the pan gently, as good balances are delicately made and a sudden jar might injure the mechanism.

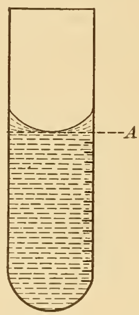


FIG. 1.—Cup on surface of liquid. *A*, line at which reading is taken.

All glass measures (no others should ever be used) must be held on a line with the eyes while being read. The surface of most liquids in a cylindrical vessel is cupped, as can be easily seen in a test-tube (see Fig. 1). All glass measures are standardized to be read at the base of this cup, and unless so read the quantities are not correctly measured.

CHAPTER II.

SOLUTIONS.

True Solution.—A true solution is a clear, transparent, homogeneous liquid having a gas, liquid, or solid dissolved in it. Hydrogen peroxide is an example of a true solution of a gas; solutions of alcohol and of salt are other examples of true solutions. There are some substances which may be thoroughly mixed with a liquid and the resulting mixture appear homogeneous temporarily but after a time the ingredients separate. Such mixtures are called **suspensions.** All emulsions are suspensions, as is also a common preparation called Compound Chalk Mixture, which is used for diarrhea. (See Experiment I.)

Parts of a Solution.—There are two parts in every solution, the liquid which forms the bulk of the solution and the substance dissolved in it. The liquid is called the **solvent**; the dissolved substance the **solute.** The most common solvent is water. Alcohol is often used, for example in the spirit of camphor and other spirits. Ether is much used in scientific laboratories and is one of the solvents in collodion. The solute, as stated above, may be a gas, a liquid, or a solid.

Solubility.—In science no substance is considered insoluble, but some are much more easily soluble than others. The solubility of a substance *varies with the*

solvent used. Oils, for example, are very slightly soluble in water and completely soluble in alcohol. A very important and practical factor which affects the solubility of a substance is the *temperature* of the solution when made. Most substances are more soluble in a hot solvent than in a cold one, and for this reason a given amount of boric acid, for example, can be dissolved more quickly in hot water than in cold. (See Experiment II.)

Saturation.—When a solvent has taken up so much of a substance that any more added simply settles to the bottom, the solution is said to be a *saturated solution* at that temperature. The following table shows the approximate quantity required to make a saturated solution of some of the common substances:

Drug.	Apoth. weight.	Metric weight.	Per cent.
Boric acid	6 drams = 1 pt.	24 Gm. = 500 Cc.	5.0
Borax (sodium borate)	6 drams = 1 pt.	24 Gm = 500 Cc.	5.0
Sodium bicarbonate	10 drams = 1 pt.	40 Gm. = 500 Cc.	8.0
Sodium chloride	4 ounces = 1 pt.	120 Gm. = 500 Cc.	26.0
Calcium oxide	7½ grains = 1 pt.	0.5 Gm. = 500 Cc.	0.1
Sodium phosphate	2 ounces = 1 pt.	60 Gm. = 500 Cc.	15.0
Magnesium sulphate	8½ ounces = 1 pt.	255 Gm. = 500 Cc.	54.0

Method of Expressing Strength.—The strength of a solution may be expressed in two ways: (1) by a **ratio** such as 1:20, read 1 to 20, or (2) by a **percentage,** for example, 5 per cent. The term per cent. means parts per 100. Therefore a solution of alcohol 5 per cent. in strength means that in 100 equal parts of the solution 5 are alcohol. A ratio means that in the number of parts expressed in the second term one part is the solute. That is, in a 1 to 20 solution of alcohol one part in every 20 is alcohol. The per cent. and ratio

do not represent definite quantities, such as ounces or pints, but express a relation between the solute and the whole solution. That is in *any* quantity of a 5 per cent. solution of alcohol the amount of alcohol is in the same relation to the whole amount of the solution as 5 is to 100: Also in a 1 to 20 solution the relation between solute and the whole solution is the same as 1 is to 20. For example in 40 Cc. of a 5 per cent. solution there are 2 Cc. of solute because 2 is in the same relation to 40 as 5 is to 100. In 16 ounces of a 1 to 4 solution there are 4 ounces of solute, because 4 is in the same relation to 16 as 1 is to 4. As a per cent. or ratio assumes that the solution is divided into equal parts the quantity of the solute and of the whole solution must be expressed in the same denomination. For example, in 100 Cc. of a 5 per cent. solution of alcohol 5 Cc. are alcohol; in 100 minims, 5 minims are alcohol; in 20 ounces, 1 ounce is alcohol.

Method of Reckoning the Percentage Strength.

The *percentage* strength of a solution may be reckoned in two ways: (1) by forming a proportion, or (2) by forming a fraction and taking that fraction of 100.

Problem.—What is the percentage strength of a solution 30 Cc. of which contain 6 Cc. of solute?

First Method: $6 : 30 :: x : 100.$

$$30x = 600$$
$$x = 20$$

Ans. 20 per cent.

Second Method: Reasoning that as 6 is $\frac{1}{5}$ of 30 the per cent. must be $\frac{1}{5}$ of 100; the actual figuring is $\frac{6}{30}$ or $\frac{1}{5}$ of 100 = 20 per cent., Ans.

RULE.—1. **Form a proportion, letting x = the per cent.**

or 2. **Multiply 100 by the fraction:**

$$\frac{\textbf{amount of solute.}}{\textbf{amount of the whole solution.}}$$

PROBLEMS.

1. If 100 Cc. of a solution contain 40 Cc. of peroxide what per cent. solution is it?
2. What percentage strength are the following:
   (*a*) 40 Cc. of solution contain 4 Cc. of peroxide.
   (*b*) 90 Cc. of solution contain 3 Cc. of phenol.
   (*c*) 20 Cc. of dilute alcohol contain 4 Cc. of alcohol.
   (*d*) f℥ij of dilute alcohol contain ʒiij of alcohol.
   (*e*) f℥iij of dilute alcohol contain ♏xlv of alcohol.
   (*f*) f℥j of a solution contains ♏xij of phenol.

Method of Reckoning the Strength by a Ratio.

When the strength of a solution is expressed in a ratio the amount of the solute is compared to 1 as a fixed basis. That is, if 20 Cc. of a solution contain 2 Cc. of alcohol it is said to be a 1:10 solution, because if the 2 Cc. be considered as a unit there would be 9 other such units (18 Cc.), or 10 in all. **The first term of a ratio is always 1 and the second term has to be determined.** It may be done in two ways:

1. By forming a proportion:

$$2 : 20 :: 1 : x$$

$$x = 10, \text{ hence the ratio is } 1{:}10.$$

2. By reasoning that if 1 is $\frac{1}{2}$ of the quantity of the solute, the second term must be $\frac{1}{2}$ of the amount of the

whole solution. Then $\frac{1}{2}$ of 20 = 10 and the ratio is 1 : 10.

RULE.—**To determine the second term of a ratio:**

1. **Form a proportion letting x = the second term of the ratio.**

or 2. **Multiply the amount of the whole solution by the fraction,** $\dfrac{1}{\text{amount of solute.}}$

PROBLEMS.

Express the strength of the following in a ratio:

100 Cc. of solution contain		20 Cc. of alcohol.	
80 ounces	"	40 ounces	"
60 drams	"	10 drams	"
6 pints	"	2 pints	"
f℥ij	"	f℥iv	"
1 liter	"	200 Cc.	"
f℥ij	"	♏xl	"
f℥j	"	♏ij	"
Oj	"	♏xc	"

Method of Converting Per cent. to Ratio and Vice Versa.

Sometimes the strength of a solution is expressed in percentage and one wishes to express it in a ratio or vice versa. This may be done by forming a proportion in each case, letting x represent the per cent. or the second term of the ratio, as the case may be, or by the following method, which is simpler:

To express 4 per cent. in a ratio.

As the first term of the desired ratio is always 1 the problem is to find the second term.

4 per cent. = 4 parts in 100

or = 4:100

The desired ratio = 1:x

x or the second term = $\frac{1}{4}$ of 100 = 25

Ans. = 1:25.

RULE.—**Take 1 as the first term and divide 100 by the per cent. to obtain the second term.**

To express 1 : 20 in a per cent.

As per cent. means so many parts in 100, the per cent. would be as many times 1 as 100 is times 20 or 5 per cent.

RULE.—**Divide 100 by the second term of the ratio.**

PROBLEMS.

1. Some solution bottles are labelled as follows. State how you would label them by ratios:

   10 per cent.; 1 per cent.; 33 per cent.; 0.1 per cent.; 5 per cent.; 0.5 per cent.

2. State how you would mark the following labels that the percentage strength may also be expressed:

   1:5; 1:20; 1:100; 1:25; 1:3; 1:40.

Relative Strength of Solutions.

Many nurses have difficulty in determining the comparative strengths of solutions, that is, whether a 5 per cent. solution is stronger or weaker than a 2 per cent. The principle of this problem is the same as in interest on money, the larger the percentage of interest on an investment the greater is the income from it. So in solutions the larger the percent. the stronger the solution.

PROBLEMS.

1. If a series of bottles of solutions were marked as follows, how would you arrange them according to strength?

   5 per cent.; 20 per cent.; 2 per cent.; 3 per cent.; 0.1 per cent.

2. Would it be possible to make the following solutions?

   (*a*) A 6 per cent. from a 2 per cent.
   (*b*) A 10 per cent. from a 20 per cent.
   (*c*) A 50 per cent. from a 20 per cent.
   (*d*) A 50 per cent. from a 100 per cent.

If the strengths are expressed in ratios they vary according to the second term. It is easily seen that a solution which contains 1 Cc. of alcohol in 5 of water is stronger than one which contains 1 in 20. Therefore **the strengths of solutions expressed in ratios vary inversely as the second term,** *i. e.,* **the smaller the second term, the stronger the solution.**

Problems.

Arrange according to strength solution bottles marked as follows:

(*a*) 1:20; 1:10; 1:50; 1:1000; 1:4; 1:500.

(*b*) 1:4; 20 per cent.; 50 per cent.; 1:25; 1:10; 6 per cent.

METHODS OF MAKING SOLUTIONS.

In pharmacy *all solutions are made according to weight.* As the kind of liquid and its temperature affect the weight of a given volume, the weights have to be reckoned according to specific gravity and temperature. Such accuracy in hospital work is unnecessary and the weight of all liquids is considered the same as water at 4° C. That is, 4 Cc. of water, alcohol, or liquid phenol is assumed to weigh 4 Gm. Therefore, if 1 ounce of alcohol is added to 99 ounces of water (a 1 per cent. or 1 : 100 solution) the solution will measure 100 ounces and weigh 100 ounces. If, however, I ounce by weight of salt is added to 99 ounces of water the salt will dissolve and not increase the volume of water. In this case the finished solution will weigh 100 ounces, but will measure only 99 fluid-ounces. It is, however, a 1 per cent. solution. There

can be no uniformity in making solutions unless this principle is followed in practice.

In regard to solutions, the most common problems for the nurse are to make a certain amount of a solution from crude material and to make weak solutions from strong ones kept in stock. In these problems no nurse should depend on a memorized rule but should understand the reasoning upon which it is based.

1. Solutions from Crude Materials.

Problem.—How much alcohol is required to make 10 ounces of a 20 per cent. (1 : 5) solution?

First Method.—Make a proportion letting x = amount of alcohol.

$x:10::20:100$	*or*	$x:10::1:5$
$x = 2$ ounces		$x = 2$ ounces

Second Method.—(*a*) *Strength expressed in per cent.* 20 per cent. means that $\frac{20}{100}$ of the whole solution is alcohol. Hence, $\frac{20}{200}$ or $\frac{1}{5}$ of 10 = 2 ounces.

(*b*) *Strength expressed in ratio.* This means that 1 part in 5 or $\frac{1}{5}$ of the whole is alcohol, hence $\frac{1}{5}$ of 10 = 2 ounces.

RULE.—First Method.—Form a proportion, letting x represent the quantity of crude material.

Second Method (*a*).—*Strength expressed in per cent.* **Multiply the amount of solution by the fraction,** $\frac{\textbf{given per cent.}}{\textbf{100}}$

(*b*) *Strength expressed in ratio.* **Form a proper fraction of the ratio and multiply the amount of solution by it,**

Problems.

(It must be remembered that the answer is in the same denomination as that in which the whole solution is expressed. It is often desirable to reduce the latter to a smaller denomination before working the problem.)

1. How much liquid phenol would be needed to make the following solutions:
   - (*a*) 40 Cc. of a 10 per cent. solution.
   - (*b*) Oiv of a 25 per cent. solution.
   - (*c*) 1 gallon (reduce to ounces) of a 1:20 solution.
   - (*d*) 1 liter (reduce to Cc.) of a 1:40 solution.
   - (*e*) 1 quart (reduce to drams) of a 20 per cent. solution.
2. Calculate amounts needed in the following solutions:
   - (*a*) 1 pint of 1 per cent. saline.
   - (*b*) 1 quart of 1:18 boric acid.
   - (*c*) ℥j of 2 per cent. cocaine.
   - (*d*) 30 Cc. of 1:6 glycerin.
   - (*e*) 1 gallon of bichloride of mercury 1:1000 using $7\frac{1}{2}$ gr. tablets.

2. Weak Solutions from Strong Ones.

When a weak solution is made from a strong solution one part of the strong solution is measured out and a certain number of equal parts of water is added to it.

In diagram *A*, Fig. 2, to make a 25 per cent. solution from a 50 per cent., which is twice as strong, one part of water must be added to one part of stock, that is, the one part of stock is diluted once with water. These two quantities may be ounces, pints or liters but they must be equal, that is they must both be expressed in the same denomination. In diagram *B* as a 60 per cent. solution is three times as strong as a 20 per cent., there will be three equal parts in the finished solution, one of stock diluted with two of water. Therefore, *if no definite quantity is required*, the problem is simply to determine how many equal parts there will be in the

finished solution; then take one of these of stock and the rest of water.

This is done by dividing the larger per cent. or second term of the ratios by the smaller. In the examples above 50 ÷ 25 or 4 ÷ 2 = 2, and 60 ÷ 20 or 5 ÷ 1.7 = 3, the quotient in each case being the whole number of equal parts.

Usually a *definite quantity* of a weaker solution is to be made as in the following:

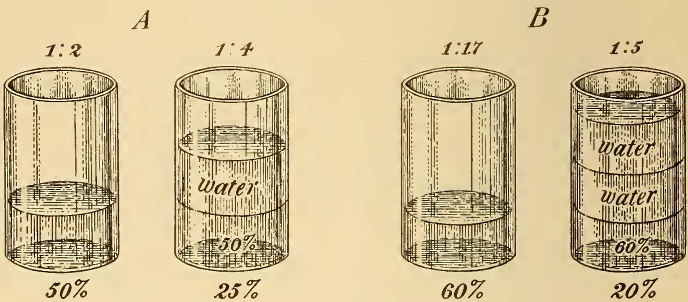


Fig. 2.—Examples of weak solutions made from strong solutions.

Problem.—Make 4 pints of a 5 per cent. solution of phenol from a stock solution 20 per cent. in strength.

In this case there are $\frac{20}{5}$ or 4 equal parts of which one is stock. Hence $\frac{1}{4}$ of 4 pints or 1 pint is the amount of stock required.

Solution:

$\frac{5}{20}$ or $\frac{1}{4}$ of 4 = 1 pt., the required amount of stock.

If the strength of the solution is expressed in ratios the number of equal parts is obtained by dividing the second terms of the ratios.

Problem.—How much 1 : 5 solution is needed to make 100 Cc. of 1 : 40?

Solution—

$$\frac{5}{40} \text{ or } \frac{1}{8} \times 100 = 12\frac{1}{2} \text{ Cc., Ans.}$$

RULE.—To determine the amount of stock solution required to make a definite amount of a weaker one, make a proper fraction of the given per cents. or the second terms of the ratios and multiply this by the desired amount of finished solution.

Problems.

1. How much 25 per cent. solution is needed to make 30 Cc. of 5 per cent.?
2. How much 1:2 solution is needed to make 40 Cc. of 1:8?
3. How much stock solution, 1:2, is needed to make the following?

Oj	of 1:10	500 Cc.	of 1:1000
f℥v	of 1:20	1 gal.	of 1:100
f℥x	of 1:4	1 qt.	of 1:50

4. How much stock solution, 48 per cent., is required to make the following?

500 Cc.	of 1 per cent.	1 gal.	of 5 per cent.
f℥xij	of 4 per cent.	1 qt.	of 3 per cent.
f℥v	of 12 per cent.	Oj	of 10 per cent.

5. How much stock solution, 1:5, is required to make the following?

50 Cc.	of 5 per cent.	f℥iv	of 1:100
Oj	of 10 per cent.	1 gal.	of 5 per cent.
f℥ij	of 1:40	Oij	of 6 per cent.

The following table gives quantities for the more common solutions:

Solution.	Apothecaries'.	Metric.
Thiersch's Solution (Borosal):[1]		
Boric acid	1½ drams	6 Gm.
Salicylic acid	15 grains	1 Gm.
Water	1 pint	500 Cc.
Potassium permanganate:		
1:1000	7½ grains to 1 pt.	0.5 Gm. to 500 Cc.

[1] The quantities used in this solution are variable.

Bichloride of mercury:

1 : 1000	7½ grains to 1 pt.	0.5 Gm. to 500 Cc.

Phenol:

1:20 (5 per cent.)	6 drams to 1 pt.	24.0 Cc. to 500 Cc.

Saturated boric acid:

1:20 (5 per cent.)	6 drams to 1 pt.	24.0 Gm. to 500 Cc.

Normal saline:

$\frac{6}{10}$ per cent.	45 grains to 1 pt.	3.0 Gm. to 500 Cc.

In approximate measure this is a rounded teaspoonful of salt to a quart or liter.

$\frac{9}{10}$ per cent.	68 grains to 1pt.	4.5 Gm. to 500 Cc.

Equivalent approximately to one level teaspoonful to a pint.

Dobell's Solution (Comp. Solution of Sodium Borate, N. F.):

Sodium borate (borax)	2 drams	8.0 Gm.
Sodium bicarbonate	2 drams	8.0 Gm.
Glycerin	4 drams	16.0 Cc.
Phenol	20 minims	1.2 Cc.
Water	15½ ounces	484.0 Cc.

CHAPTER III.

PHARMACEUTICAL PREPARATIONS.

Pharmacy.—Pharmacy is the art and science of preparing drugs for medicinal use. The forms into which they are made are called pharmaceutical preparations. Laws governing pharmacies and the State examinations for pharmacists are becoming more and more rigid. For eligibility to the State examinations for pharmacists a person must have had a full course in some recognized school of pharmacy and have served a considerable time as an apprentice. A pharmacist's work is exacting and full of responsibility but to one of a scientific trend of mind it is most interesting.

Legal Standards.—The legal standards for pharmaceutical preparations in the United States are the **United States Pharmacopeia** (**U. S. P.**) and the **National Formulary** (**N. F.**). An official drug or preparation is one which is described in these books. The Pharmacopeia is revised every ten years by a committee of about thirty members, who are appointed each decade by a national convention of physicians and pharmacists at Washington. The revision and publication require about five years. The book contains a description of the drugs and preparations which are of known value and are most used. The American Pharmaceutical Association publishes the National Formulary every ten

years after the publication of the new Pharmacopeia. It contains the formulæ of many common preparations not included in the Pharmacopeia. These books were made official by the Pure Food and Drugs Act (p. 265).

The American Medical Association publishes every year **New and Non-official Remedies**, a book which contains a description of new preparations and non-official drugs which, according to their Council on Pharmacy and Chemistry, are worthy of trial and honestly marketed.

This Association also publishes **A Hand-book of Useful Drugs** which contains a brief description of those drugs and preparations considered most useful to the medical profession. The choice of drugs here included was determined by the Council on Pharmacy and Chemistry after lists were twice submitted to teachers and deans of medical schools, to state medical examiners and others.

CLASSIFICATION.

I. Solutions:

A. Aqueous	water. solution. mucilage. syrup.
B. Alcoholic	spirit. elixir.
C. Other menstrua[1]	glycerite. oleate. collodion.

II. Extracts:

1. Infusion.
2. Tincture.
3. Wine.
4. Fluidextract.
5. Extract.
6. Syrup.
7. Oleoresin.

[1] Menstruum is the word used in pharmacy for solvent.

III. Other Preparations:

A. Suspensions in water	emulsion, mixture.
B. Mixtures characterized by base	liniment. triturate. ointment. cerate.
C. Mixtures characterized by form	pill. suppository. powder. plaster. paper.

In the study of the following preparations the Pharmacopeia should be consulted freely for illustrations and methods of procedure. Some exceptions to the definitions will be noted. There are three important factors in every preparation: (1) **form**, liquid or solid; (2) **nature**, solution or extract; (3) **ingredients.** (See Experiment III, page 257, for directions for laboratory work).

Solutions.

A. Aqueous Solutions.—Solutions of drugs in water have a twofold advantage: water is cheap and it has no medicinal action. Their disadvantage is that they do not keep unless the dissolved substance is preservative.

(*a*) A **water** (aqua) is a clear aqueous solution of a volatile substance. The volatile substance may be a gas, as in ammonia water, but more often is a volatile oil, as in cinnamon water. Waters of the latter kind are weak preparations of a drug used as flavors.

(*b*) A **solution** (liquor) is an aqueous solution of

a non-volatile substance, usually of an organic salt, such as solution of ammonium acetate.

(*c*) A **mucilage** (mucilago) is an aqueous solution of a gum, such as mucilage of acacia. These preparations are inert medicinally, and are used for soothing applications (demulcents) and as vehicles for potent drugs.

(*d*) A **syrup** (syrupus) is a dense sugar solution containing a drug or some extract of a drug.

B. Alcoholic Solutions.—The advantage of these preparations is that alcohol is a preservative; the disadvantage is that alcohol has a medicinal action of its own which in some cases is undesirable and which may affect the action of the drug dissolved in it.

(*a*) A **spirit** (spiritus) is an alcoholic solution of a volatile drug, *e. g.*, spirit of camphor.[1]

(*b*) An **elixir** is a dilute spirit flavored and sweetened. Most elixirs contain 25 per cent. of alcohol, one-half as much as whisky, and for this reason their use is now largely discontinued.

C. Other Menstrua.—(*a*) A **glycerite** (glyceritum) is a solution of a drug in glycerin. Glycerites keep well, are less irritating than alcoholic solutions, and because of the adhesive property of glycerin are used on mucous membranes when continuous medication is desired. Glycerite of tannic acid is an example.

(*b*) An **oleate** (oleatum) is a solution of a drug in oleic acid. Oleates, such as the oleate of mercury, are indicated especially for inunctions because oleic acid

[1] The terms *spirits* of camphor and *spirits* of turpentine are incorrect. The singular form should be used for an individual preparation.

is absorbable by the skin and substances, if dissolved in oily solutions, enter the circulation by this channel more readily than in other solvents.

(*c*) A **collodion** (collodium) is a solution of a drug in collodion. Collodion is a very inflammable solution in ether and alcohol of pyroxylin, a substance similar chemically to gun-cotton and celluloid. Flexible collodion is a mixture of Canada turpentine (Canada balsam), castor oil, and collodion.

Extracts.

The purpose of the process of extracting a drug is to separate the active principles from the inert, solid portion of the crude drug. The liquid used to extract any individual drug is determined by the solubilities of the active principles in that drug. For example, alcohol will extract the oils from a crude drug because they are soluble in it. The liquid extracts are, therefore, solutions of that portion of the crude drug which is soluble in the particular menstruum used for extraction.

1. An **infusion** (infusum) is a liquid preparation made by extracting a drug with boiling water. Infusions are the weakest preparations (5 per cent.) made by extraction. They do not keep well.

2. A **tincture** (tinctura) is a liquid preparation made by extracting a drug with alcohol, absolute or dilute. According to an international agreement tinctures of all *potent* drugs are 10 per cent. in strength, that is, a dose of 10 minims of the tincture contains 1 grain

of the drug.[1] Most tinctures of *non-potent* drugs are 20 per cent. in strength. The tinctures of ferric chloride, Tolu, and iodine are not true tinctures but merely solutions of the whole drug in alcohol.

3. A **wine** (vinum) is a tincture made with wine as a menstruum. It is of better flavor but does not keep well.

4. A **fluidextract** (fluidextractum) is a liquid preparation made by extraction of a drug with a suitable menstruum and so made that one minim represents one grain of the drug or one cubic centimeter represents one gramme of the drug. Fluidextracts are the most concentrated fluid preparations, being 100 per cent. in strength. They have an advantage over tinctures because of the smaller dose and the smaller amount of alcohol they contain. So many of them precipitate in the light that they should be kept in dark bottles and should not be used if much precipitate is present.

5. An **extract** (extractum) is a solid or semisolid preparation made by evaporating a liquid extract. Most potent extracts are four times the strength of a fluidextract, *i. e.*, 1 Gm. of an extract represents 4 Cc. of a fluidextract or 1 gr. of extract represents 4 minims of fluidextract. The extracts are used chiefly in making pills.

6. A **syrup** (see page 42).

7. An **oleoresin** (oleoresina) is an extract which contains the resins and oils of the crude drug. Acetone is the menstruum usually used for the extraction.

[1] This is the only point upon which the pharmacopeias of all civilized countries agree.

Other Preparations.

A. Suspensions in Water.—(*a*) An **emulsion** (emulsum) is a suspension of an oil or resin in water by means of an emulsifying agent. A gum is the agent most used. If well made an emulsion should keep its homogeneity for at least six months.

(*b*) A **mixture** (mistura) is generally a suspension of a solid in water. Chalk Mixture is a familiar example.

B. Mixtures Characterized by the Base.—(*a*) A **liniment** (linimentum) is a liquid preparation for external use, containing one or more drugs mixed with alcohol or an oil as a base.

(*b*) A **triturate** (trituratio) is a dry mixture of a drug and milk of sugar (saccharum lactis). The purpose of this mixture is to prepare in a usable form a drug the dose of which is very small. A tablet triturate is this mixture made into very soft and soluble tablets. Calomel tablets are an example.

(*c*) An **ointment** (unguentum) is a mixture of a drug and a fatty base such as petrolatum (vaseline), lard or lanolin.

(*d*) A **cerate** (ceratum) is an ointment whose base is made more firm by adding wax or paraffin. The heat of the body softens the base of an ointment and a cerate, and enables the drug to come in contact with the tissues.

C. Mixtures Characterized by Form.—(*a*) A **pill** (pilula) is a mixture of a drug and some adhesive substance made in certain shapes and sizes according to convenience or some definite use. A very large pill

is called a *bolus,* a very small one a *granule,* a flat pill a *troche* for use in throat medication. Compressed pills or tablets are made by machines which press the dry materials into desired shapes. They are hard and not easily soluble. An example is ammonium chloride tablet.

(*b*) A **suppository** (suppositorium) is a mixture of a drug and a firm base, usually cacao butter, made into suitable shapes for insertion into the rectum, vagina, or urethra. Cacao butter melts at body temperature, thus allowing the drug to come into contact with the mucous membranes.

(*c*) A **powder** (pulvis) is a finely divided solid drug or mixture of drugs. If intended for internal use powders are dispensed in folded papers (chartulæ), in gelatine capsules, or rice-flour wafers, (disks, cachets, or konseals). The capsules are swallowed dry; the wafers are softened first by immersing them in water. **Effervescing powders** are mixtures of a drug, sodium bicarbonate, tartaric acid, and sugar. The purpose of the sugar is to flavor; of the sodium bicarbonate and tartaric acid to cause the effervescence by their chemical reaction when in solution. A familiar example is a Seidlitz powder (Compound Effervescing Powder). Effervescing powders are more agreeable to take and the carbon dioxide gas formed by the chemical reaction is slightly stimulating to the stomach. All effervescing powders must be kept tightly stoppered.

(*d*) A **plaster** (emplastrum) is a medicated adhesive mass spread on cloth. When applied to the skin the body heat softens the mass sufficiently to make it adhere.

(*e*) A **paper** (charta) is a paper covered or impregnated with some medicinal substance. A mustard paper (charta sinapis) is the only official paper.

POSOLOGY.

Posology is the study of the dosage of drugs. The responsibility of dosage rests wholly upon the physician. A nurse should always be on the alert to detect errors, but should never of her own accord change an order.

There are very few rules in dosage, but it is of assistance to compare the usual doses of some preparations which are fairly uniform.

Infusions:	℥ij–iv	60–120.0 Cc.
Exception:		
Inf. of digitalis	ʒij	8.0 Cc.
Emulsions:	ʒj–ij	4–8.0 Cc.
Tinctures:		
Potent:	♏x or less	0.6 Cc.
Non-potent:	ʒj	4.0 Cc.
Fluidextracts:		
Potent:	♏j	0.06 Cc.
Non-potent:	ʒss	2.0 Cc.
Extracts:		
Potent:	gr. $\frac{1}{4}$	0.015 Gm.
Non-potent:	gr. ii–iv	0.1–0.25 Gm.

The more common potent drugs are nux vomica, belladonna, opium, digitalis, aconite, and hyoscyamus. Examples of non-potent drugs are gentian, calumba, and cardamom.

Factors which Determine Dose.—There never can be any fixed dose of a drug to be given under all circumstances for there are many factors which influence its action. The *climate*, the *nature of the disease*, the *weight, sex, temperament*, and *physical condition of the individual* all have to be considered in regulating a dose in any particular case. Many people are poisoned by drugs which ordinarily are perfectly safe. Such a condition is said to be an *idiosyncrasy*. If a nurse knows that her patient has such an idiosyncrasy she should warn the doctor, for it is a condition which he could not in any way detect.

Rules for Children.—**Infants under a year old** are given approximately $\frac{1}{15}$ or the fraction, $\frac{\text{age in months,}}{150}$ of the adult dose. There are several methods of calculating doses for **children under twelve years of age**, but the most common is to multiply the adult dose by the fraction, $\frac{\text{age in years}}{\text{age} + 12}$. For example, if an adult dose is ♏xij, the dose for a child six years old is $\frac{6}{6+12} = \frac{1}{3} \times 12$ or ♏iv.

Problems.

1. The dose of the tincture of digitalis is 1 Cc. (♏xv). What is dose for child two years old?
2. The dose of morphine is 0.01 Gm. (gr. $\frac{1}{8}$). What is dose for child eight years old? Ten months old?
3. The dose of hexamethylenamine is 0.3 Gm. (gr. v). What is dose in milligrammes for child six months old? Four years old?
4. The dose of sulphonal is 1 Gm. (gr. xv). What is dose for child ten years old?
5. The dose of camphorated tincture of opium (paregoric) is f℥ij. What is dose for baby five months old?

METHOD OF CALCULATING FRACTIONAL DOSES.

From Tablets.—Nurses are often called upon to give different fractional doses from tablets of one-sized dose which are kept on hand. For example, it may be necessary to give strychnine gr. $\frac{1}{20}$ when the only tablets on hand are gr. $\frac{1}{60}$, or gr. $\frac{1}{120}$ from gr. $\frac{1}{60}$. If the dose to be given is an even number of times larger than the tablet dose on hand, then that number of whole tablets can be given. In the above example, three tablets of gr. $\frac{1}{60}$ each would equal gr. $\frac{1}{20}$. In all other cases, however, the tablets have to be dissolved in a certain number of minims of water and a fraction of that quantity taken as the dose.

Problem.—Give strychnine gr. $\frac{1}{30}$ when you have on hand tablets gr. $\frac{1}{20}$.

First Step.—Determine whether the desired dose is larger or smaller than the dose on hand. In this case gr. $\frac{1}{30}$ is smaller than gr. $\frac{1}{20}$. In any problem the fraction which has the larger denominator is the smaller fraction.

Second Step.—Determine what fraction of the dose on hand is wanted. This is done by reducing the fractions to a common denominator and dividing the desired dose by the dose on hand.

$$\frac{1}{30} = \frac{2}{60}$$

$$\frac{1}{20} = \frac{3}{60}$$

Then the desired dose is $\frac{2}{3}$ of the dose on hand.

Third Step.—Select a suitable quantity of water which will contain the denominator of this fraction an even number of times. Dissolve the tablet in it. The desired dose will be the fraction of this amount.

30 minims is a suitable quantity of water in this case. Then if one $\frac{1}{20}$ gr. tablet be dissolved in this, $\frac{2}{3}$ of it, or 20 minims, will contain the desired dose, gr. $\frac{1}{30}$. If the desired dose is larger than the dose on hand, for instance, ^{3} of it, first substract 1 from it and proceed to obtain the remaining fraction of a dose. To the amount of solution thus obtained add a whole tablet. In this case $\frac{3}{2} - 1 = \frac{1}{2}$. Dissolve one tablet in ♏xl of water. $\frac{1}{2}$ of ♏xl is ♏xx. Then add one whole tablet to ♏xx and you will have $\frac{3}{2}$ of the original dose.

Problems.

1. If $\frac{1}{30}$	gr. tablet	on hand,	how would	you give	gr. $\frac{1}{15}$?
2. If $\frac{1}{6}$	gr.	"	"	"	"	gr. $\frac{1}{10}$?
3. If $\frac{1}{5}$	gr.	"	"	"	"	gr. $\frac{1}{4}$?
4. If $\frac{1}{20}$	gr.	"	"	"	"	gr. $\frac{1}{60}$?
5. If $\frac{1}{100}$	gr.	"	"	"	"	gr. $\frac{1}{60}$?

From Solutions.—In some hospitals the drugs commonly given by hypodermic injection are kept in solution, a certain number of minims of the solution containing a certain dose. For example a solution bottle of morphine will be labelled ♏x = gr. $\frac{1}{8}$. In calculating different fractional doses in this case the problem is exactly the same except that the drug is already dissolved in a given quantity of water.

Problems.

1. ♏x contain morphine sulphate gr. $\frac{1}{8}$. How many minims required to give gr. $\frac{1}{6}$?

   Solution: $\frac{1}{6}$ is larger than $\frac{1}{8}$. $\frac{1}{6} = \frac{4}{24}$, $\frac{1}{8} = \frac{3}{24}$. Then the required dose is $\frac{4}{3}$ of ♏x or ♏xiij.

2. How many minims of above solution are required to give morphine gr. $\frac{1}{10}$? morphine gr. $\frac{1}{4}$?

3. ♏x contain strychnine sulphate gr. $\frac{1}{30}$. How many minims required to give gr. $\frac{1}{150}$? gr. $\frac{1}{60}$? gr. $\frac{1}{50}$?

4. 0.6 Cc. of solution contain 2 mg. What fraction of a cubic centimeter would contain 1 mg.? 3 mg.?

PART II.

INTRODUCTION TO THE STUDY OF DRUGS.

CHAPTER IV.

DEFINITIONS.

ALL knowledge in regard to drugs is included in the term Materia Medica. Literally translated, **Materia Medica** means a study of all the materials of medicines, including appliances and instruments as well as drugs. The term is usually used, however, to mean a study of the history, source, characteristics, and doses of drugs. The terms, drug and medicine, are used interchangeably. A drug is the more comprehensive word, meaning "any substance other than food stuff or a mechanical agent which produces changes in living organisms" (Tyrode). If these changes are beneficial the drug is a medicine; if harmful, a poison.

Pharmacy and **posology** have been previously described. **Pharmacognosy** is a technical study of drugs, including their gross, microscopic, and chemical structure. A pharmacognosist can identify crude

drugs by their appearance to the naked eye, by cross-sections under the microscope, and by chemical tests. This wide knowledge has made possible standardization of drugs and their preparations, so that a pharmacist can determine whether the material he is buying is adulterated or below standard in strength.[1]

Pharmacology is the study of the action of substances, apart from foods, on living organisms. This is largely an experimental science carried out on the lower animals. It is now agreed that the action of drugs will be similar on animals which have a similar physiology. Its great contribution is in determining exact methods by which various drugs produce their effects and the action of new synthetic remedies before they are used on man.

All these facts about drugs are of little use without a knowledge of their application to the diseases of man. The art and practice of administering remedies in the treatment of disease is called **Therapeutics.** There are various branches of therapeutics, named according to the agent used as a remedy. The important branches are **Psychotherapy**, the use of the mind over that of the patient; **Hydrotherapy**, the use of water; **Electrotherapy**, the use of electricity; **Serumtherapy**, the use of serums; **Radiotherapy**, the use of various kinds of rays.

[1] Read the minute description in the U. S. P. of digitalis, strychnine, and the assay of fluidextract of nux vomica.

CHAPTER V.

HISTORY.

THE art of healing is probably as old as man. Ancient works of medicine show that drugs were then given because of some fancy or superstition in regard to their value, and that medical practice consisted largely in the invoking of spirits by priests. It is believed that the cross line in the sign ℞ which heads every prescription is a relic of an ancient symbol of prayer for the blessing of the gods on the remedy. In early times in Egypt there were well-organized systems of medicine and a comprehensive knowledge of hygiene. The Mosaic laws in the Bible form a wonderful sanitary code even in the light of modern science.

In the direct line of priest doctors in Greece, Hippocrates was born in 460 B.C. Hippocrates was a philosopher as well as priest, and also a great teacher. He founded the dogmatic school of medicine, which believed in treating the cause of disease instead of its symptoms, and this school marks the separation of medicine from the priesthood, the beginning of the modern medical art. In this sense Hippocrates is rightly called the "Father of Medicine." In his written works he mentions 265 drugs, but in his belief drugs were secondary to diet and external treatment.

His Materia Medica was made up chiefly of vegetable drugs and one-tenth of these were bitters.

For nearly 2000 years after the time of Hippocrates there was little advance in medical knowledge, but during this period there are a few important names. Galen, a Greek living in Rome in the early Christian era, was a prolific medical writer who left invaluable records of his profession. He prepared and preserved in his writings many medicinal recipes. The adjective "galenical" derived from his name is in common use, "galenical" preparations being those made by physical processes, such as extracts, tinctures, and infusions in distinction from alkaloids, glucosides, and chemically extracted principles. Galen's idea of the action of drugs was very primitive. He classified all drugs as hot, cold, moist or dry, and he believed in curing by contraries, a moist drug being indicated for a dry condition of the mouth or skin, a hot one for a chill. Dioscorides, of Cilicia, about 78 A.D., wrote a Materia Medica in which five hundred different plants are described, and which is still an authority on plants and drugs of ancient times.

Arabian medicine, introduced with other sciences into Europe in the 11th century, dominated all Europe for nearly two centuries. The Arabs developed schools of pharmacy as well as schools of medicine. They made new medicinal preparations and formulated the first known pharmacopeia. The general outline of pharmacy and many names and forms of drugs as we know them originated with the Arabs. Alcohol, senna, benzoin, and borax are words of Arabic origin.

The one name which still survives as great from the Arabs is Avicenna, a philosopher and physician who lived 980–1037 A.D.

The predominance of Arabian medicine in Europe was destroyed in the 14th century by the revival of the works of Hippocrates and Galen. The writings of these men had not before been widely known, and the study of them brought new information, not only about systems of medicine, but also about the properties of medicinal plants. The discovery of America also brought many new plants, and of more importance still was the introduction of chemical medicines from the stimulus given by a famous German doctor, Paracelsus, who lived 1490–1541.

Paracelsus was an arrogant, independent man. Living at the same time as Luther, he was as true a reformer in medicine as the latter was in religion and education. He cast aside as worthless all previous medicinal writers, excepting possibly Hippocrates. He declared his shoe-buckles were more learned than was Galen or Avicenna. "The Book of Nature," he said, "is that which the physician should read, and to do so he must walk over its leaves." He went to mines and labored as a miner to learn of metals, not for the gold but for the healing of mankind; he travelled in all countries, and talked with boors, shepherds, Jews, gypsies and tramps, everywhere gathering up knowledge. Browning in his poem "Paracelsus" gives what is thought a very correct characterization of the man and his noble purposes. His work in chemistry, especially on minerals, marked a distinct

advance in this line, and from his time there existed chemical schools of medicine. Paracelsus rebelled against the horrible smelling and tasting concoctions in vogue and taught the use of tinctures and quintessences. He introduced mercury as a cure for syphilis, and first gave the name "laudanum" to the tincture of opium.

The next century after Paracelsus, the 17th century, marks the first real progress since the time of Hippocrates. The sciences of chemistry and physiology began to develop and their teaching, along with the new scientific method of research, had the most profound influence on medicine. Mysticism still prevailed but was being gradually pushed to one side. Materia Medica was in a hopeless state. There were great numbers of drugs known and used, many of them absolutely inert. Coupled with this fact was the extreme confidence of the people in drugs, the number, bad taste, and foul smell being standards of worth. Consequently prescriptions were advocated containing from 20 to 70 different drugs, the so-called "shotgun" prescriptions. Disgusting remedies, such as excrements of animals, blood of executed criminals, moss grown on a human skull, and earth from a grave, were still in use.

A man who did much to aid the advance in medical methods at this time was Dr. Sydenham, an English doctor, who is sometimes called the English Hippocrates. In his lifetime he acquired no great fame but later generations recognized the extent of his influence and his name is now an eminent one in medical history. He advocated and used little medicine

but a great deal of common sense. His ideas were slowly disseminated, as is shown by a statement in a cook-book published in London in 1781, one hundred years later. Under care of wounds is this statement: "Mankind in general believes in herbs, ointments, and plasters. It is a fact, however, that nothing avails except keeping the parts soft, clean, and defending them from the air. It is Nature alone that cures wounds." Then follow directions for cleansing the foreign matter from the wound.

In the 18th century, following Dr. Sydenham, there were two events which greatly affected Materia Medica. One was the rise of Homeopathy through a Dr. Hahnemann of Dresden. He believed that drugs should be given for the totality of symptoms present at any one time and that infinitesimal doses were more effectual than larger ones. Hahnemann exerted indirectly a marked influence on the medical profession in two ways: (1) in teaching that no two drugs should be given at the same time, thus counteracting the custom of wholesale drug-giving and, (2) in showing that disease tends to recovery without medical interference.

Equally important with Hahnemann's influence in the 18th century was the rise of the new science of Pharmacology. The first work in this science was in 1765, proving that drugs affect specific organs and tissues of the body. The first pharmacological laboratory was established in Germany in 1850.

The progress in medicine in the 19th century was phenomenal, but due largely to improvements in methods of investigation and diagnosis and to more

precise instruments for use in laboratories and in practise. One writer has said that the 19th century taught doctors what not to do, as it abolished disgusting and senseless remedies and the absurd practices of bleeding and purging. In 1805 an obscure apothecary in Germany, named Sertürner, first isolated an alkaloid, morphine. His discovery is considered one of the greatest of the 19th century. As his method of separating out the alkaloid is essentially the same as used today, and as such alkaloids as strychnine, quinine, atropine, and morphine are of vital importance to modern medicine, his name may well be called great.

About 1890 there was a movement called Nihilism, which advocated the entire abolition of all drugs. This represented the extreme elements in the profession, but from that time the sentiment has fast grown that drugging is no longer the chief function of the doctors. There is now in process of formation a new school of medicine which has a firm faith in a few well-tried drugs, such as quinine, iron, mercury, opium and digitalis but little or no faith in the majority of them. So the increased knowledge of drugs has brought two results, an aversion to their indiscriminate use and an increased confidence in their powers when in the hands of practitioners who understand their properties. The tendency at the present time is toward the use of fewer drugs with a better understanding of their action.

CHAPTER VI.

ADMINISTRATION OF MEDICINES.

The fact that many medicines are deadly poisons should be sufficient to impress upon every nurse the need of great care in their administration. Many hospitals have a list of rules posted on the door of every medicine closet as a means of avoiding mistakes, but if each nurse will picture to herself the ruin of her whole after-life in case she causes the death of a patient by giving a wrong medicine, how can she forget to be careful!

Care of Closet.—The condition of the medicine closets and bottles is an important factor in avoiding mistakes. All poisons should be kept in rough-glass bottles, so that the feel of the bottle may be a reminder of extra precaution. All bottles should be well labelled and arranged in a systematic order. Every bottle should have a good stopper to prevent contamination from the air and to prevent evaporation in the case of volatile preparations. Nearly all medicines deteriorate with age, and if there is any doubt about their condition they should be examined by a chemist or, if that is not feasible, should be destroyed.

Accuracy.—While measuring medicines a nurse must give her whole and best attention to the task. If she is unusually tired because of extra duty she must exert double care. It is no time for conversation, listening to news, or attending to what others are

doing. Be sure that the right medicine is being given, then that it is measured exactly. If a doctor orders ♏x he does not want ♏xij to be given. Inaccuracy in measuring is sometimes due to lack of proper utensils. A minim dose less than ten minims cannot be measured accurately in an ordinary minim glass. Neither is it accurately measured in drops from an ordinary glass dropper. Either pipettes or graduated minim droppers should be used.

Methods of Pouring.—The contents of a bottle are only as clean as the inside of the cork which is in the neck. To keep this clean while pouring a dose, remove the cork with the second and third fingers of the left hand, holding the backs of the fingers next to the bottle, and retain it between these fingers while it is out of the bottle. A medicine bottle is very unsightly if the contents have run down over the label. To avoid this, when pouring from the bottle, hold it with the label toward the palm of the hand, and wipe off the edge afterward.

Preparation.—Practically all medicines, except cough medicines, are given diluted with water. This water should be very cold if the preparation is to be given cold; very hot if given hot. Acids and inorganic iron preparations should never be allowed in contact with metal utensils or with the teeth. Measure them in glass vessels, mix them with a glass rod, and give them to the patient through a straw or glass tube.

Time.—Medicines which are intended to relieve disorders of digestion are usually given with some definite relation to meals that they may act while the digestive processes are going on. Irritating drugs are

given after meals that they may mix with the food and be kept from contact with the walls of the stomach. Cathartics are given according to the length of time that it takes them to act. The object, whenever possible, is to cause the bowels to move at their regular time, preferably early in the day. If drugs are used to secure a prompt action after absorption, they should be given between meals, at least one hour after or half an hour before meals.

Oils are best given from one to two hours after meals, as they tend to interfere with digestion.

Two medicines should never be given at the same time unless so ordered.

Names of Drugs.—The labels of medicine bottles commonly bear the chemical or Latin names of the drugs, such as phenyl salicylate for salol and spiritus frumenti for whisky. The object in thus avoiding the popular names is usually to conceal the nature of the drug from patients.

There is, however, another reason why nurses and doctors should be familiar with the chemical names of drugs. There are many drugs on the market with patented names, and the price of these drugs or of prescriptions containing them when purchased under the patented name are often as much as 100 per cent. higher than when purchased under the chemical name. Examples of this are thymol iodide which under the name of Aristol, until the patent expired, was one of the most expensive drugs on the market. Hexamethylenamine can be purchased for a much lower price than the same drug under the name of urotropin, formin, or other patent name.

CHAPTER VII.

TOXICOLOGY.

Toxicology is the study of the detection, action, and antidotes of poisons. One suspects that a poison has been taken when some sudden violent symptom occurs such as vomiting, collapse, or convulsions. The duty of the nurse is first to send *some other person* for a physician and before his arrival find out, if possible, what poison has been taken and how much, and then to apply suitable first-aid antidotes. Only first-aid antidotes are considered in this chapter. Further treatment is left to the physician.

ANTIDOTES.

Antidotes are the agents used to counteract the effect of a poison, and are of three kinds, *physical, chemical,* and *physiological.*

A **physical antidote** is one which envelops the poison, thus preventing its absorption, and soothes and protects the surface of the tissues. Those which are soothing and protective are called **demulcents.** The following may be used as demulcents: milk, white of egg, boiled starch, flour and water (best when boiled), gruels, barley-water, mashed potato, and mucilage of acacia. These may all be given freely. The fixed oils, such as olive oil, are demulcents, but

must be used with care for in some cases, as in phosporus poisoning, they aid in the absorption of the drug.

A **chemical antidote** is one which reacts chemically with the poison and breaks it down. (See Experiment VII, p. 261.) Care must be taken in the selection and amount of a chemical antidote. It must itself be non-poisonous and form in the reaction non-poisonous products. The amount to be given is determined by the amount of the poison taken, but if the latter is not known large amounts should not be given. Common salt is a safe chemical antidote for silver nitrate, as both products, silver chloride and sodium nitrate, are relatively harmless. Other examples are lime-water for acids and vinegar for alkalies. Sodium bicarbonate and magnesium carbonate are commonly used as chemical antidotes for acids, but are not entirely safe because the chemical reaction yields carbon dioxide gas which by pressure might cause perforation of the stomach. As a rule an emetic is given after a chemical antidote.

A **physiological antidote** is one which produces the opposite systemic effect from that of the poison. For example, caffeine is the physiological antidote for morphine because it stimulates the nerve centres which are depressed by morphine.

General Outline of First-aid Treatment in Poisoning.

1. Lose no time but give the best thing nearest at hand.

2. For poisonous gases secure abundant fresh air and give artificial respiration.

3. For **non-irritant poisons** give a chemical antidote, if one is known, and remove at once by stomach-tube, cathartics, emetics, and diuretics. Sometimes, as in cases of poisoning by alkaloids, the stomach is washed out with a chemical antidote, such as potassium permanganate. The stomach-tube, if quickly available, is the most effective means of removing poisons. The best simple emetic is warm water with or without salt. Mustard water, copper or zinc sulphate and ipecac, are all more or less uncertain, slow, and irritating to the stomach. (See Emetics, page 180.) Apomorphine, gr. $\frac{1}{10}$, given subcutaneously, is quick and sure. It is the only available emetic when a patient is unable to swallow. As a rule magnesium sulphate or citrate are the best cathartics for *non-irritant* poisons. Castor oil may be used for irritant poisons. Water should be given freely as a diuretic.

4. For **corrosive** and **irritant** poisons[1] give a suitable chemical antidote and demulcents. If there is an extensive destruction of tissue the stomach-tube or emetics cannot be used for fear of perforation of the wall of the esophagus or stomach.

5. Whenever possible avoid the use of the stomach-tube in the absence of the physician.

[1] Such substances are acids, alkalies, chlorides of zinc, tin, antimony and mercury, nitrates of silver and mercury, sulphates of copper, zinc, and iron, lead salts, and phosphorus.

Antidotes of Common Poisons.

Poison.	Antidote.	Safe Dose of Antidote.
Acids.	Lime-water.	1–2 glasses undiluted.
	Milk of magnesia.	½ glass undiluted.
	Sodium bicarbonate.	½ t. in glass of water.
	Magnesium carbonate or oxide.	Half an ounce (15 Gm.) in glass of milk or water.
Oxalic acid.	Lime-water.[1]	1–2 glasses undiluted.
Alkalies.	Vinegar.	1 T (15 Cc.) in glass of water.
Organic poisons (alkaloids and glucosides. See pp. 81, 82).	Potassium permanganate.	Claret-colored solution, preferably followed by an emetic or use as lavage. Let no undissolved crystals enter the stomach.
	Hydrogen peroxide.	½ glass of 50 per cent.
	Tannin in tea.[2]	Freely.
Metallic salts.	Tannin.	As above.
	Whites of eggs.	2–4 eggs.
	Milk.	Freely.
Silver nitrate.	Sodium chloride.	2 t. in water.
Iodine.	Starch.	1:15 in water.
Phenol.	External use—pure alcohol.	Freely.
	Internal use—whisky.	Preferably in the form of lavage diluted four times with water.
Phosphorus.	No oil.	
	Potassium permanganate.	As above.
	Copper sulphate.	½–1 glassful of a light blue solution.
Arsenic.	White of egg.	Freely.
	Milk.	Freely.

[1] This is of little use unless given *at once*. If none is at hand, make some by putting into water a piece of plastering from the wall.

[2] Add boiling water to large amounts of tea (about a handful to a pint). Steep for two minutes to extract the caffeine. Pour off this infusion and add fresh boiling water. Boil briskly for five to fifteen minutes according to the urgency of the case. This fluid will contain the maximum of tannin.

PART III.

STUDY OF DRUGS—MISCELLANEOUS.

CHAPTER VIII.

ACIDS AND ALKALIES.

ACIDS and alkalies[1] are used both as local and systemic medicines. By a **local medicine** is meant one whose therapeutic action is at the point of application on the skin or mucous membranes. A **systemic medicine** is one given for its action on some distant organ or tissue after absorption. This is sometimes spoken of as remote action in distinction from local. Gargles and salves are all local remedies. Brain stimulants, heart tonics and general tonics are systemic remedies.

Local Physical Action.—An important *local* use of acids and alkalies is the purely physical one of supplying a deficiency in the alimentary canal. Hydrochloric acid is commonly used to supply a deficiency of hydrochloric acid in the stomach, and chalk, lime-water

[1] Alkalies in this chapter include the free alkalies, sodium, potassium, and calcium hydroxide and alkali salts, such as the carbonates and bicarbonates.

or magnesium carbonate to supply a deficiency of alkali in the intestine. The former is indicated in certain forms of gastric indigestion, the latter in intestinal indigestion and diarrhea, such as the summer diarrhea of children, due to excessive acid fermentation.

Local Chemical Action.—Another local use of acids and alkalies is based on their power of neutralizing each other. In excessive acidity of the stomach an alkali, such as sodium bicarbonate, lime-water, and magnesium carbonate or oxide, may be used.

The other local uses of acids and alkalies depend upon two chemical properties: (1) that of withdrawing water from the tissues due to their affinity for it; (2) that of coagulating albumin from the protoplasm of the cells. (See Experiment IV, p. 260.) All living cells contain a proportionately large amount of albumin which is in its general characteristics like albumin of an egg. By heat and by various agents this albumin may be coagulated and it then has the same appearance as the white of an egg when cooked. In living tissues if the coagulation has not proceeded too far the albumin can be restored to its natural state. The white appearance of tissue around an acid burn is due to the coagulated albumin. The whitening of the hands after being held in even a weak solution of phenol is due to the same action.

Local Therapeutic Effects.—Any agent applied to living cells which causes a rearrangement of their constituents and thus an increased activity within the cells is an irritant. Very often a mild irritation is beneficial by creating increased blood supply and

greater nutrition, and *such a mild irritation is usually equivalent in therapeutics to a stimulation.* If, however, the irritation is violent, the cells are destroyed and the result is *corrosion* or *cauterization.* Hence *weak* acids and alkalies are stimulants and *strong* ones corrosives.

As Stimulants.—In therapeutics much use is made of the stimulant action of acids and alkalies. Vinegar or other acids are used in baths to stimulate the sweat glands; potassium carbonate, an alkaline salt, in baths for dry, scaly skin affections; fruit acids such as lemonade and grape-juice to stimulate the mucous and salivary glands and allay thirst; sodium and potassium bitartrate (Rochelle salt) and magnesium citrate to cause catharsis by irritating the intestinal walls.

As Caustics.—In practice only acids are used as caustics. The action of alkalies is with difficulty limited to prescribed areas. Nitric, acetic and trichloracetic acids are used for snake-bites, certain growths and sores on the skin; arsenous acid for killing dental nerves. The galvano- and thermocautery[1] have largely displaced chemicals as caustics, because the action is more prompt, less painful, and can be easily controlled.

As Antizymotic.—Acids and alkalies are destructive also to certain ferments and bacteria; hence they are antiseptic. Boric acid is the acid commonly used externally. Dilute hydrochloric and phosphoric acid are taken *before* meals to check the activity of the

[1] Galvanocautery is an apparatus for cauterization by electricity. Thermocautery is an apparatus which by a blow flame heats a metal tip to red heat.

gastric ferments. Any drug given to check ferment action is called an **antizymotic**. Vinegar is popularly used for obesity for this reason. If acids or alkalies are taken for any reason over an extended period they so interfere with ferment action as to derange digestion. Phosphoric acid is the most easily tolerated by the stomach over long periods.

As Astringents.—The albumin precipitated by *moderately strong* acids is hard and puckers the tissues. This constitutes a true astringent action (see p. 239). It is made use of in some forms of diarrhea and externally in tubercular night-sweats, excessive sweating of the feet, and itching skin diseases. Sulphuric acid and vinegar are used in this way.

As Solvents.—*Very weak* acids and alkalies form a coagulated albumin which is soft and soluble, and for this reason they are used to soften and dissolve away accumulations of tough mucus in cases of diphtheria, croup, and catarrh of the stomach. Lactic acid or lime-water in a spray and the fumes of slaking lime are used for this purpose. Alkaline salts in baths for dry skin diseases act as solvents as well as stimulants.

Systemic Effects.—*On the Blood.*—If more acid or alkali is taken into the alimentary canal than can be neutralized or used there, the excess does not pass in a free state into the blood, but in loose chemical combination with protein. It is quite impossible to give enough acid or alkali by mouth to alter materially the reaction of the blood. A certain degree of alkalinity of the blood is necessary to the life of the tissues, and this is maintained by a complex mechanism in connection with urea formation in the liver.

On the Urine.—The administration of acids and alkalies do, however, affect the reaction of the urine, acids making it more acid, and alkalies making it less acid or even alkaline. Phosphoric acid, benzoic acid, sodium bicarbonate, and potassium acetate are in most common use for this purpose.

Organic Acids.—The organic acids,[1] citric, tartaric and acetic, act in the same way as inorganic acids *in the alimentary canal,* but when absorbed they are oxidized to carbonates which are alkaline. Hence, the systemic action is that of alkalies. Citric acid, for example, will neutralize an alkali in the stomach, but neutralizes acid in the urine. This explains its use in rheumatism.

Administration.—The dose of acids is from 1 to 15 minims (0.1 to 1 Cc.). They should be kept closely stoppered with glass stoppers. The alkali salts are given in doses of 15 to 30 grains (1 to 2 Gm.). In baths for stimulation the inorganic acids are used in the proportion of 1 ounce (30 Cc.) to a bath (30 gal. or 120 L.). The alkali salts, sodium and potassium carbonate, may be used in the strength of 3 ounces (100 Gm.) per bath, and sodium bicarbonate, 8 ounces (250 Gm.) to 1 gallon (4 L.).

For their antizymotic action acids and alkalies are

[1] Common organic acids are lactic, tartaric, citric, salicylic, and acetic. Common inorganic acids are hydrochloric, sulphuric, phosphoric. In chemistry all compounds are divided for convenience into two groups, organic and inorganic. Organic compounds contain carbon as one of their constituents, *e. g.*, acetic acid ($HC_2H_3O_2$) and lactic acid ($C_3H_6O_3$). Inorganic compounds do not contain carbon, *e. g.*, hydrochloric acid (HCl) and sulphuric acid (H_2SO_4). The carbonates and bicarbonates contain carbon in their radicals, CO_3, but they are considered inorganic compounds.

given *before* meals; to supply deficiencies, *after* meals. Some physicians prescribe an acid mixed in a glass of water and taken at intervals through the meal. In this way it is thoroughly mixed with the contents of the stomach.

Cautions in Giving Acids.—Always dilute the acid. Prepare in a glass container and stir with a glass rod. Give through a glass tube. Discontinue if symptoms of griping and diarrhea appear.

CHAPTER IX.

SALTS.

Salts must be *soluble,* at least in the juices of the alimentary canal, to be of use as systemic medicines. Otherwise they pass through the body without effect as does a coin. If they are *soluble but non-absorbable,* such as the sulphates, they act only locally on the walls of the alimentary canal.

Salt Action (see Experiment V, page 260).—An important action of salts depends on the principle of osmosis which is that if two solutions are brought in contact through a membrane they tend to equalize in concentration. The membranes in the body are the cell walls. These are all permeable to water and to some solids in solution, such as sodium chloride. According to this principle if cells are put into a sufficiently dilute solution of some salt they swell, because water passes into them from the dilute solution outside until the concentration inside and outside is equalized. Likewise if cells are put into a sufficiently concentrated solution they shrink, because water passes out of them into the concentrated solution until the two are of equal strength. This process in connection with drugs is called "salt action," because it is so marked in the case of certain salts, but it takes place also with almost any soluble substances, such as acids, alkalies, and

sugars, and is still called salt action. The general effect of salt action is to change the watery content of cells and this change alone is often sufficient to produce the desired therapeutic result. Examples of the effect of salt action are the watery defecations following administration of saline cathartics, the so-called flushing of the system by drinking large quantities of water, and diuresis caused by certain salts such as potassium acetate.

Selective Action.—The walls of different kinds of cells vary in their permeability and this may account for the fact that when a drug is in circulation around all kinds of cells it acts only on one or two kinds. Strychnine, for instance, acts only on nerve centres, epinephrine on nerve endings. This is spoken of as the *selective action of drugs.*

Chemical Action.—Many salts also exert a chemical action, the exact nature of which is not known. They may combine temporarily with constituents of the cells or they may merely by their presence modify cell activity.

Local Action.—The universal *local* action of salts is to break down protoplasm, forming albuminates and acids. Their therapeutic use depends on the character of these products. If the albuminates are soluble the drug is an irritant or caustic; if insoluble, it is an astringent. This is shown in the following equations:

$HgCL_2$	+	protoplasm	→	HgAlb	+	2HCl
Bichloride of mercury.				Albuminate of mercury.		Hydrochloric acid.

The albuminate of mercury is relatively soluble and hydrochloric acid is a strong acid, hence mercuric chloride is a corrosive. This action explains its use as an antiseptic.

$AgNO_3$	+	protoplasm	$\rightarrow$	AgAlb	+	HNO_3
Silver nitrate.				Albuminate of silver.		Nitric acid.

As the albuminate of silver is less soluble than that of mercury and nitric acid is less strong than hydrochloric, silver nitrate is a less powerful caustic than bichloride of mercury.

$Pb(C_2H_3O_2)_2$	+	protoplasm	$\rightarrow$	PbAlb	+	$2HC_2H_3O_2$
Lead acetate.				Albuminate of lead.		Acetic acid.

Lead albuminate is insoluble, acetic is a weaker acid, hence lead acetate is an astringent.

Changes in the Body.—When the metallic salts are taken internally they undergo many changes in their course to the cells. Iron, for instance, in whatever form taken becomes the chloride in the stomach, the carbonate in the duodenum, the albuminate in the blood, and the metal is probably deposited free in the cells. These changes very much complicate the administration of medicines and until a better knowledge of their nature is obtained therapeutics will fail to be an exact science. As the metallic part of many inorganic salts is desposited free in the cells, the action of such salts depends to a certain degree on the action of the metal. The salts of the more common metals will be considered from this point of view.

Action of Metals.—The salts of **sodium, potassium, calcium,** and **magnesium,** especially of the first two, are much used as medicines and are seldom toxic for two reasons. The metals are normal constituents of protoplasm and their excretion is more rapid than their absorption.

The salts of **copper** and **zinc** have a highly irritant local action, in some cases amounting to a corrosion. Zinc chloride is the base of many cancer cures and is used in legitimate medicine as a caustic for superficial cancers. Because they are irritants large doses of these salts cause vomiting before they have time to do much harm. Large doses, even if not vomited, do not cause systemic poisoning because the metals are excreted very rapidly. Copper in food which is cooked in copper utensils or tinted green by it is not injurious beyond a local irritation of the alimentary canal.

The salts of **mercury** are especially toxic because (1) mercury is absorbed very rapidly; (2) it is corrosive to all kinds of tissues; (3) it is among the slowest of all metals to be excreted. Mercury is absorbed from the skin as well as from the alimentary canal. When absorbed it is deposited largely in the kidneys and is excreted from them very slowly. Fatal results are due primarily to injury to the kidneys.

The salts of **lead** are absorbed much faster than excreted, hence they accumulate in the body. They are absorbed chiefly from the alimentary canal and from the lungs. Cases of lead poisoning in industry are due to lead-laden dust and to the failure of work-

men to wash their hands before eating. Lead affects chiefly the circulatory and nervous systems, causing the varied symptoms of lead colic, anemia, neuralgia, and paralysis. Lead subacetate, as a local astringent, is the only lead salt used in medicine.

Arsenic salts are toxic because they accumulate in the body like those of lead. They may be absorbed from the unbroken skin. In large doses they produce in the alimentary canal a condition resembling an extreme inflammation.

CHAPTER X.

ACTIVE PRINCIPLES OF MEDICINAL PLANTS.

Source of Medicinal Plants.—Drug-yielding plants grow in all parts of the world: the valleys of Asiatic Turkey, the deserts of Africa, the mountains of South America, and various parts of Europe and North America. The knowledge of their medicinal value in many cases was first obtained from the natives by missionaries, explorers, and traders. A very intensive study has been made of these plants to determine the best species, the part of greatest value, and the most favorable conditions for their collection. The following outline will show the variety of sources of vegetable drugs.

Drug.	Part of Plant Used.	Chief Source of Supply.
Camphor.	Wood or twigs.	China.
Witch hazel.	Leaves or root.	United States.
Ergot.	Fungus.	Russia.
Ipecac.	Roots.	Brazil.
Podophyllum.	Rhizome.	Middle West, U. S.
Squills.	Bulb.	Malta, island in Mediterranean.
Senna.	Leaves.	Egypt.
Arnica.	Flowers.	Germany.
Strychnine.	Seeds.	India.
Capsicum.	Fruit.	India and Africa.
Cascara.	Bark.	California.
Opium.	Juice of capsule.	Asiatic Turkey.
Turpentine.	Exudation.	Southern U. S.

The increased demand for drugs has long ago exhausted the native supply of most of them, and the raising of medicinal plants is now one of the important industries of the world. When the desired part has been collected it is carefully dried and shipped to market usually in this crude dry form. The great crude drug markets of the world are London in England, New York in the United States, Hamburg in Germany, Trieste in Austria, and Marseilles in France. All crude drugs coming into the United States are examined at the point of entry by the Department of Agriculture, and the careful work of that department in recent years has practically checked the importation of adulterated drugs.

Active Principles (see Experiment VIII, page 261).—Within the last century chemists have found that the medicinal action of a plant is due to one or more of its chemical constituents. The constituents which determine the action of a plant are called its **active principles.** The chief classes of active principles are oils, glucosides, alkaloids, resins, tannins, and saponins. If the active principle of a plant can be isolated and given pure as a medicine its action is usually more prompt, more reliable, and freer from side actions than preparations of the whole plant from which it is derived. The chief active principle of opium is morphine, and gr. $\frac{1}{4}$ of morphine is more effective than one grain of opium.

Oils.—The oils used in medicine are the fixed and volatile oils. These differ in that the volatile oils are entirely volatilized by heat while the fixed oils are

decomposed by it. Linseed, cod-liver, and olive oils are examples of fixed oils. They are used in medicine as nutrients and as demulcents. Examples of volatile oils are the oils of peppermint, wintergreen, turpentine, and cloves. Because of their aroma they are used as flavors; because of their volatility and consequent power of penetration they are irritants and mild stimulants. The irritant action of a mustard plaster is due to the volatile oil of mustard. The value of oil of peppermint in colic is due to its slight stimulation of the mucous membrane of the alimentary canal. Volatile oils are sometimes called essential oils from an early belief that the chief value of a plant was its oils. An essence such as the essence of peppermint is an alcoholic solution of a volatile oil and in pharmacy is known as a spirit.

Glucosides.—A glucoside is defined as a substance which when acted upon by an acid yields glucose or sugar as one of its decomposition products. The name usually ends in -in. Examples are digitalin, a glucoside of digitalis, and salicin, a glucoside from willow and poplar trees, sometimes used as a substitute for salicylates in rheumatism.

Saponins.—Saponins are compounds which foam when agitated with water. They are non-absorbable, hence act only locally and they are powerful gastro-intestinal irritants. The action of sarsaparilla is largely due to a saponin. Quillaja, soap bark, was used as an emetic because of the irritant action of its saponin on the stomach.

Alkaloids.—The alkaloids are defined as organic bases which contain nitrogen. The common alkaloids are here given with their chemical formulæ to show their similarity of composition.

Morphine	$C_{17}H_{19}NO_3$
Strychnine	$C_{21}H_{22}N_2O_2$
Cocaine	$C_{17}H_{21}NO_4$
Atropine	$C_{17}H_{23}NO_3$
Quinine	$C_{20}H_{24}N_2O_2$
Nicotine	$C_{10}H_{14}N_2$
Epinephrine	$C_9H_{13}NO_3$

Their names end in -ine to distinguish them from glucosides. They are bitter to taste, slightly alkaline in reaction, most are insoluble in water, but react with acids to form soluble salts. For this reason the soluble salts, morphine and strychnine sulphates for example, are used as medicines instead of the alkaloids themselves. The salts in solution are broken down by the oxidizing agent, potassium permanganate, and it acts as an antidote to them in cases of poisoning. Tannic acid, usually given in the form of tea, is another antidote. It reacts with the salts of the alkaloids and forms insoluble compounds. If salts are formed from the halogen acids, hydrochloric, hydrobromic, and hydriodic, the hydro- prefix in the name of the acid is retained in the name of the salt. Examples are cocaine hydrochloride and homatropine hydrobromide. There is a tendency among recent writers to drop the prefix.

Resins.—Resins are compounds which are soluble in alcohol but insoluble in water. Solid resins are brittle and resemble rosin, the resin in turpentine, used by violinists. Resins are local irritants and are

commonly used in medicine as cathartics. Examples are podophyllin, the resin of podophyllum, and the resins of gamboge and jalap. A substance composed of a resin and a gum is a *gum resin* of which myrrh and asafedita are examples. A resin combined with a volatile oil forms an *oleoresin*. Crude turpentine is a natural oleoresin composed of the oil of turpentine and rosin.

Tannins.—It is impossible to define tannins as their composition is unknown. An important property of tannins is that they form insoluble compounds with alkaloids, as stated above. They also form insoluble compounds with albumins, hence are astringent in action. The most common drug of which tannin is the active principle is hamamelis. The only rational use of hamamelis is as an astringent.

PART IV.

STUDY OF DRUGS BY SYSTEMS.

CHAPTER XI.

DRUGS WHICH ACT CHIEFLY ON THE NERVOUS SYSTEM.

An exact arrangement of drugs by systems or by classes is impossible as many of them fall into more than one system or class.

Types of Drug Action.—The **physiological action** of a drug means the action which it has on a healthy animal. Some drugs act differently on a healthy organism than on a diseased one. Caffeine, for instance, does not affect a normal brain but will stimulate a tired brain. The action of a drug on a diseased organism is called its **therapeutic action.** Usually the physiological action and the therapeutic action of a drug are the same.

Drugs are said to be **synergistic** when they have a similar effect on an organ, **antagonistic** when they have the opposite effect. (See page 94.) Many drugs have actions besides those for which they are given, some being very undesirable. Morphine given to

relieve pain often causes nausea; atropine given to check sweating will cause dryness of the throat. These undesired effects are called **side actions**, and if they are disagreeable are termed **untoward actions**.

When the exact method of action of a drug is not known and it is used because experience has proved it beneficial in similar cases, it is said to be an **empiric** remedy or to have an empirical use. A **rational** remedy is one the method of action of which is understood.

Methods of Action.—The diagram on page 87 is given to assist in understanding the drugs which act upon the nervous system. Some act wholly on the central system, some on the nerve endings or periphery, and some on both. In the central system are located limited areas of nerve cells which have control of certain definite functions. These are called the *nerve centres*. In the brain are the higher centres which control the will, thought, and consciousness and through these the whole body; in the medulla are the so-called "vital centres," the respiratory which controls the respiration, the accelerator which increases the heart beat, the vagus which slows the heart, the vomiting centre which controls emesis, the vasomotor centre which when stimulated causes the walls of the arteries to contract and when depressed causes them to dilate, and probably a heat centre. No attention should be paid to the relative location of these centres. It is important to remember simply that they are in the medulla. In the spinal cord are the *reflex* centres which control most reflex acts and the *motor* centres which regulate muscular activity.

Some of the nerve trunks which leave the central system pass through the sympathetic ganglia and some

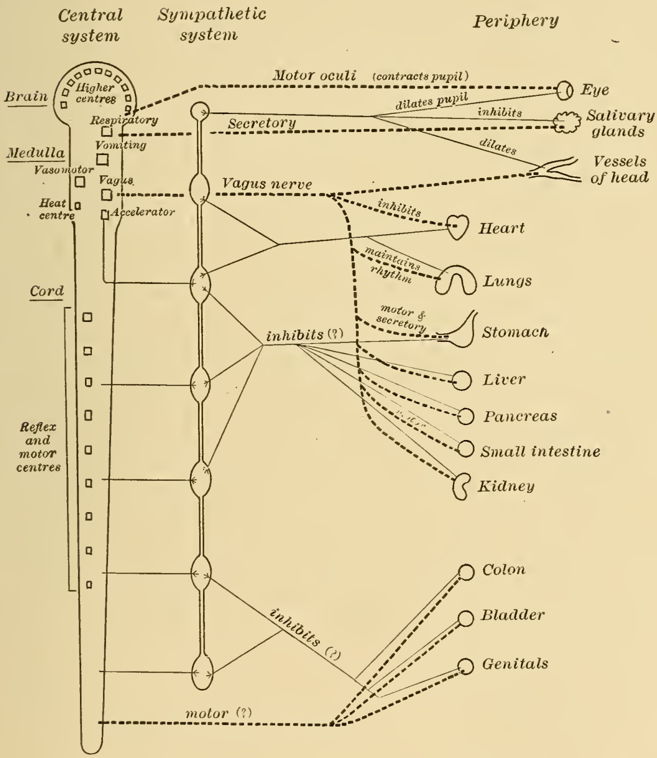


FIG. 3.—Diagram of the nervous system. (Modification of diagram by Meyer and Gottlieb.) The nerves which do not pass through the sympathetic system are in dotted lines. The functions of some of the branches are not understood at all and others are in dispute.

do not. (See diagram.) On the whole these two sets of nerves are antagonistic to each other in action.

There must be some distinct difference between them because some drugs act on the endings of one kind only (see Atropine, page 96, and Epinephrine, page 159).

Drugs affect nerve cells in only two ways: they either *stimulate* or *depress* them. A stimulating drug increases the function of the centre or ending upon which it may act; a depressant drug lessens the function. For example, if a drug stimulates the accelerator centre the heart beats faster, if it depresses it the heart beats more slowly. A general condition of stimulation is characterized by excitability, alertness, restlessness, and a quickened heart and respiration. Overstimulation of the central system often leads to convulsions. The characteristic features of a general depression are lack of attention to surroundings, quiescence, dull eyes, and a slow pulse and respiration. Excessive depression of the central system ends in delirium or stupor, paralysis, coma, and death usually by paralysis of the respiratory centre.

The classes of drugs which act on the nervous system will be considered in the order given in the following classification:

Action on Central Nervous System:

Central stimulants.	General anesthetics.
Central depressants.	Analgesics.
Hypnotics.	

Action on Periphery:

Local anesthetics.	Mydriatics.
Anodynes.	Myotics.

Antispasmodics.

ACTION ON THE CENTRAL NERVOUS SYSTEM.

Central Stimulants.

Strychnine.—History.—Strychnine is an alkaloid derived from the seeds of nux vomica,[1] a small straggling tree of India and parts of China. The seeds are imbedded in a pulpy fruit resembling a small orange. Nux vomica was unknown in ancient medicine and was probably brought to Europe by the Arabs. The first description of it in medical literature of Europe was about 1640. It was then said to be of great use "to kill dogs, cats, crows, and ravens, but of little use in medicine." The alkaloid was discovered about 1820 and has largely supplanted the drug from which it is derived. Nux vomica is now used only as a convenient form in which to give strychnine when a prolonged action is desired.

Action on Cord.—The action of strychnine is to stimulate the central nervous system, *small doses* affecting chiefly the cord and *large doses* affecting also the medulla. In *toxic doses* it continues to stimulate these centres to the point of convulsions, but between the convulsions there is excessive depression, and death is due to paralysis of the respiratory centre. *In the spinal cord* the action of strychnine is confined chiefly to the reflex centres, making them more receptive

[1] The following crude drugs are of special interest for demonstration when their action is being studied; nux vomica seeds, stramonium leaves, opium capsule, methyl alcohol, digitalis leaves, ipecac roots, quassia chips, podophyllum rhizome, senna leaves, cascara bark, rhubarb rhizome, theobroma nuts, ergot, Spanish flies.

to impulses coming to them and more active in transmitting impulses to the motor areas. There follows, therefore, an improvement of all functions which are reflex in character—respiration, heart action, digestion, and nutrition; and, as a result of this, an increased tone of all muscles and a general state of well-being.

Action on Medulla.—When the dose of strychnine is sufficiently large to act upon the medulla, the *respiratory centre* is chiefly affected and to some extent the *vasomotor*. Strychnine has no direct action on the heart and its slight stimulation of the vasomotor centre has little affect on blood-pressure. Therefore when blood-pressure is very low, as in shock, it is of little value. In small repeated doses *as a tonic* the circulation is benefited indirectly by the improved general condition. The central nervous system itself is not directly benefited by strychnine, but indirectly as is the circulation. Because of its bitter taste strychnine, like any bitter, improves digestion.

Therapeutic Uses.—The therapeutic uses of strychnine are based directly on its physiological action. They may be summarized as follows:

1. In large doses in crises to improve respiration and blood-pressure.

2. In smaller doses over prolonged periods as a general tonic.

3. In constipation, diarrhea, and indigestion, to improve the muscular tone of the alimentary canal.

4. As a bitter to improve gastric digestion.

5. As an antidote to central depressants such as ether and chloroform.

PLATE I

Strychnos Nux Vomica—Poison Nut.

(Courtesy of Parke, Davis & Co.)

Dosage.—Strychnine sulphate is the salt usually used. *As a tonic* it is given in doses from gr. $\frac{1}{60}$ (1 mg.) to gr. $\frac{1}{30}$ (2 mg.); *as a stimulant* from gr. $\frac{1}{30}$ (2 mg.) to gr. $\frac{1}{20}$ (3 mg.). The fatal dose is $\frac{1}{2}$ grain or more. Strychnine is an ingredient of Compound Laxative Pills (A. S. and B. pills), each pill containing about gr. $\frac{1}{125}$ (0.5 mg.). It also enters into the composition of many tonic preparations such as Elixir of Iron, Quinine, and Strychnine Phosphates.

Preparations of nux vomica are preferred when a prolonged effect is desired, as in disorders of the alimentary canal, because they are absorbed slowly. The *tincture* is commonly used as a tonic. The average doses are in accordance with the general rules on page 47.

Tincture (10 per cent.)	♏x (0.6 Cc.)
Extract	gr. $\frac{1}{4}$ (0.015 Gm.)

One grain (0.06 Gm.) of nux vomica contains approximately gr. $\frac{1}{100}$ (0.6 mg.) of strychnine, hence each dose of the above preparations contains gr. $\frac{1}{100}$ (0.6 mg.) of strychnine.

Toxicology.—Even therapeutic doses may occasionally be followed in 15-30 minutes by nervousness and twitching of the muscles, and these symptoms should be reported. Moderate overdoses will cause the same symptoms. Toxic doses usually cause within fifteen minutes a sudden convulsion. As it is the reflex centres which are overstimulated the slightest sound, touch, or bright light will cause a convulsion.

The spasms are intermittent alternating with periods of extreme depression. If treatment can be begun before the onset of convulsions, the stomach should be washed out with potassium permanganate or tea. If lavage is impossible give the antidote and an emetic. If convulsions have already set in, only symptomatic treatment can be given. Artificial respiration and inhalation of oxygen are the best measures to relieve the convulsions and the depression of the respiratory centre. Morphine must not be given for it increases the depression. Chloroform may be administered during a convulsion, but with great care lest it, too, add to the depression which is sure to follow the spasm.

Caffeine.—Source.—Caffeine is a white crystalline substance usually obtained in commerce from damaged tea leaves. It is the active principle of many plants used as beverages, such as coffee, tea, kola in Africa, guarana in South America, and Paraguay tea.

Action on Nervous System.—Whereas strychnine *in small doses* acts chiefly on the cord, caffeine stimulates chiefly the higher centres, causing wakefulness and increased mental efficiency. *Large doses* stimulate the medulla and cord, but on account of the extreme wakefulness and nervousness resulting it is less useful than strychnine for this action. In treatment of poisoning by depressants, however, caffeine is better than strychnine, because it is a pure stimulant to the higher centres and does not end in depression.

Action on Muscles.—In *small* doses caffeine stimulates the muscles, increasing their power to do work; in *large* doses such as are taken in the excessive use of

coffee as a beverage it has the opposite effect, causing a condition in the heart like fatigue with palpitation and intermissions. In treatment of depressant poisons the dose must be regulated to avoid this action on the heart.

Diuretic.—In certain conditions caffeine is an active diuretic, that is, a drug which increases the flow of urine. This has been shown to be due in part to a local action on the kidneys, as it takes place equally well in an isolated kidney. (See Caffeine, page 205.)

Therapeutic Use.—Because of the stimulant action of caffeine on the cerebral centres it is used in headaches, mental fatigue and depression, and as an antidote to depressant drugs such as morphine and alcohol. It is especially useful as a diuretic in cases of cardiac dropsy and is considered a valuable item in a soldier's diet to increase muscular endurance.

Administration.—The average dose of caffeine is about 2 or 3 grains (0.1–0.2 Gm.). It is often given in the form of coffee. An ordinary cup of coffee or tea contains from 1 to 2 grains (0.06–0.1 Gm.). Coffee as a beverage increases mental capacity in *fatigue* but not in normal conditions. The stimulation of caffeine in coffee and tea is increased by the volatile oils which give them their flavor. The tannin contained in both tends to derange digestion. In the roasting of coffee a highly irritating oil is formed which also disturbs digestion and may have a laxative effect. *Citrated caffeine* is a mixture of caffeine with an equal part of citric acid to make it more soluble. The dose is 2 grains (0.1 Gm.). The dose of *Effervescent Citrated*

Caffeine is $\frac{1}{2}$–2 drams (2–8 Gm.). Caffeine with sodium benzoate or salicylate are other mixtures which render the caffeine more soluble and they are well adapted to hypodermic use. The dose is 2 grains (0.1 Gm.) Caffeine is an ingredient of *Compound Acetanilid Powder,* a headache remedy. The two drugs, caffeine and acetanilid, are synergistic in their effect on the headache but caffeine increases the toxic action of acetanilid on the heart. (See page 132.)

Toxicology.—An excess of caffeine, pure or in coffee, causes nervousness, mental depression and palpitation or intermittent action of the heart. Toxic doses may result in strychnine-like convulsions. The treatment is removal of the poison and absolute rest.

Camphor.—**Source.**—Camphor is a tough, white, crystalline substance derived from the camphor tree, a handsome evergreen in China and Japan. It used to be obtained wholly by distillation of the wood, but it has been found that the twigs, leaves, or even sap yield as good a product and they are now being used in order to save the trees. Artificial camphor is made in large quantities in Germany and to some extent in this country.

Action and Use.—*Locally* camphor is a mild stimulant, antiseptic, and counter-irritant. It has a wide use in liniments (camphorated oil) and in the form of the spirit or the water for gastro-intestinal disorders. The dose of the **spirit** is 15 minims (1 Cc.) given on sugar; of the **water** about 2 drams or 10 Cc. Camphor is an ingredient of soap liniment, chloroform liniment, and several diarrhea mixtures such as Sun Cholera Drops

and Squibb's Diarrhea Mixture. The *systemic* action of camphor is that of a central stimulant. Therapeutic doses (2 grains—0.1 Gm.) affect chiefly the brain and are useful in some forms of hysteria. In even larger doses in olive oil or alcohol it is given intramuscularly as a heart stimulant in crises. If the first dose has good

Fig. 4.—Camphor tree grown in Florida. From U. S. pamphlet. "Camphor cultivation in the United States."

results it will prove a valuable stimulant; if not, repeated doses are useless and even unsafe.

Atropine.—History.—Atropine is an alkaloid from the leaves and roots of belladonna, a native plant in southern Europe. A certain amount of belladonna

in the market is obtained from northwestern United States. The name belladonna was derived from an early use of the drug by beautiful women of Italy to produce a lustre of the eyes. Atropine was named by the famous botanist, Linné, for Atropos, the mythical fate who cuts the thread of life.

Central Action.—Atropine acts chiefly on the vital centres of the medulla, especially the respiratory centre. It stands on the borderline between central stimulants and central depressants, because while it stimulates in *therapeutic doses,* if certain rather narrow limits of dosage are exceeded, the stimulation passes to depression, and *large doses* cause complete depression and paralysis. Because of this early tendency to depression atropine is not a drug for a nurse to use without orders. The doses have to be carefully regulated and even in treatment of poisoning large doses cannot be repeated at frequent intervals. Cases of morphine poisoning in which atropine was used as a physiological antidote are on record where the patients recovered from the effects of the morphine only to die later from depression by the atropine. In cases of mental excitement and insanity atropine seems to have a very fleeting stimulating action on the brain centres followed by a beneficial depression which quiets the mania. For its stimulant action on the respiratory centre atropine is used *in moderate doses* before anesthesia, in crises, and as an antidote to central depressants.

Peripheral Action.—The most important uses of atropine are based on its effect on nerve endings.

Whether used locally or internally atropine paralyzes the endings of all nerves which do not pass through the

Fig. 5.—Belladonna plant. Grown in the New York Botanical Garden, Bronx Park, New York City.

sympathetic ganglia. (See diagram, page 87.) As a result it accelerates the heart, it dilates the pupil of the eye, it diminishes the secretion of sweat, mucus,

saliva, gastric juices, and milk, and tends to relax overcontracted involuntary muscles in spasmodic conditions as in asthma, colic of the bile ducts, stomach, intestines or kidney, and spasms of the heart, bladder, or uterus. When applied locally atropine also paralyzes *sensory* endings and is used in solutions, ointments, and plasters of belladonna for neuralgia, pleurisy and lumbago to relieve pain. Atropine can be absorbed through the skin, and while being used locally any systemic effects should be reported immediately.

Therapeutic Uses.—The therapeutic uses of atropine may be summarized as follows:

1. By local applications to relieve pain and to dilate the pupil of the eye.
2. To check secretions.
3. To check spasms of involuntary muscles.
4. To stimulate respiration.

Administration.—The common preparations for *local* use are the **liniment, ointment,** and **plaster of belladonna. Belladonna leaves** are burned and the fumes inhaled for asthma. For *systemic* action **atropine sulphate** is used: (1) to stimulate the respiratory centre, dose gr. $\frac{1}{60}$ (1 mg.); (2) to paralyze nerve endings, dose gr. $\frac{1}{120}$–$\frac{1}{160}$ (0.5–0.4 mg.). The maximum dose is gr. $\frac{1}{50}$–$\frac{1}{20}$ (1.2–3 mg.). A 1 per cent. solution is used in the eye. The preparations of belladonna given internally are as follows: the tincture (10 per cent.), 8 minims (0.5 Cc.); the fluidextract, 1–2 minims (0.06–0.1 Cc.); and the extract, $\frac{1}{5}$ grain (0.01 Gm.).

Toxicology.—The early symptoms of overdoses of atropine are dryness of the throat and dilatation of the

pupil of the eye. There frequently occurs flushing of the face or eruptions of the skin. The central action causes first excitability, then delirium followed by paralysis. The mental symptoms of atropine poisoning are so slow to develop and so prolonged that they have led to diagnoses of insanity. For this reason belladonna used to be a favorite drug for poisoning with criminal intent.

The early treatment is lavage with potassium permanganate. Artificial respiration should be started as soon as any symptom of depression is detected. As the final stage of poisoning is depression, stimulants are indicated, the best of which is caffeine.

Drugs Allied to Belladonna.—In the botanical family to which belladonna belongs there are other medicinal plants whose active principles are atropine or other alkaloids similar in action. These are hyoscyamus, scopola, and datura stramonium. The following outline shows their similarity:

Crude drug.	*Alkaloid.*
Belladonna	atropine.
	hyoscyamine.
Hyoscyamus (henbane)	scopolamine (hyoscine).
Scopola	scopolamine.
	atropine.
	hyoscyamine.
Stramonium	hyoscyamine.

Active Principles.—Belladonna owes its activity to atropine and to hyoscyamine, which have practically

the same actions. Hyoscyamus contains hyoscyamine and another alkaloid, scopolamine, which has the same peripheral action as atropine, but a more pronounced depressing action on the central nervous system. Scopolamine predominates and determines the action of hyoscyamus and also of scopola. When the alkaloid of scopola was isolated, it was named scopolamine from the name of the plant, and it has since been found that the alkaloid of hyoscyamus which was named hyoscine is identical with it. Stramonium owes its activity to hyoscyamine.

Therapeutic Uses.—These drugs and their alkaloids all resemble atropine, but have come to have certain special uses. **Hyoscyamus**, because of the predominance of scopolamine, is used as a sedative for children and the insane and to relieve inflammatory conditions of the bladder.

Scopolamine itself is an efficient sedative in insanity and alcoholic delirium. Patients should be carefully watched after its administration as it not infrequently causes severe depression and collapse. It has been and is still under much discussion as a preliminary to the anesthetic in surgery and for the production of the so-called "twilight sleep" in obstetrics.

The complete development of a method of painless childbirth by this drug is the work of Dr. Krönig and his assistant, Dr. Gauss, at the Frauenklinik in the University of Baden at Freiburg, Germany. This method depends upon the power of scopolamine when properly given to cause a state of semiconsciousness in which the sense of pain is reduced and memory

of it abolished, but the patient retains control of her muscles and ability to respond to requests. Factors absolutely essential to this kind of sleep are quiet, semidarkness, ceaseless watchfulness on the part of the nurse and doctor, and tact in applying the tests of memory. The condition of the memory is the symptom by which the dosage of the drug is regulated. The first dose of scopolamine is combined with morphine and is usually given as soon as the pains are regular. After the first dose scopolamine in diminishing doses is as a rule given alone about every hour.

Scopola has no place in medicine. **Stramonium** leaves, the only form of that drug used, are burned and the fumes inhaled to relax the muscular walls of the alveoli and bronchi in asthma.

Dosage.—As the dose of hyoscyamus itself is larger than that of nux vomica and belladonna, the doses of the pharmaceutical preparations are correspondingly larger: the tincture (10 per cent.), dose ♏xxx (2 Cc.); the fluidextract, dose ♏iij (0.2 Cc.); and the extract, dose gr. j (60 mg.). The dose of scopolamine hydrobromide is gr. $\frac{1}{125}$ (0.5 mg.).

Central Depressants.

Morphine.—Description.—Morphine is the chief alkaloid of opium. Opium is the dried, milky juice from the capsules of the poppy plant. Although this drug is usually associated with China because of its extended use there for smoking, the supply for medicine comes from Asiatic Turkey. The cultivation of opium

was an industry in that country before the time of Christ. All the early medical writers describe it. Probably the Arabs were responsible for its introduction into Persia and thence to China where it became a national curse as "smoking dirt." The first edict in China against the cultivation and use of smoking opium was in 1796, but not until in very recent years have radical measures taken by the government and missionaries shown any appreciable results in removing the curse from the nation. The United States imposes a duty of $6 a pound on smoking opium but very large quantities are brought in by smugglers. It is estimated that 70,000 pounds a year would supply the demand for medicine, while 500,000 pounds annually come into the country.

Action on Brain.—The action of morphine on the nervous system is confined chiefly to the central portion, and it is predominately that of *depression.* In *small doses* the effect on the *brain* is to dull its power of perception, especially of pain. If insomnia is present due to pain *small doses* of morphine are often sufficient to produce sleep *if the external conditions are favorable. Large doses* will compel sleep in spite of conditions. *Toxic doses* produce a stupor. Morphine surpasses all other drugs in its power to relieve pain and insomnia due to pain. Other medicines, less depressing and less liable to form a habit, are to be preferred in insomnia not due to pain.

Action on Medulla.—Morphine also acts on the medulla, depressing the respiratory centre, slowing the heart, and stimulating the vomiting centre.

PLATE II

Papaver Somniferum—Opium Poppy.

(Courtesy of Parke, Davis & Co.)

Through its depression of the respiratory centre morphine relieves cough. It does not cure but simply alleviates symptoms. If there is profuse bronchial secretion with the cough its use is dangerous, for an accumulation of mucus in the lungs might cause suffocation. Morphine before anesthesia is not without some danger, as it renders the respiratory centre more susceptible, especially to chloroform. The slowing of the heart is due either to depression of the accelerator centre or stimulation of the vagus. This effect is sometimes desired in therapeutics for nervous conditions of the heart. The stimulation of the vomiting centre with resulting nausea and vomiting are disagreeable but seemingly unavoidable side actions of morphine with small doses. Larger ones depress the vomiting centre and check emesis.

Action on Cord.—In animal experimentation it has been shown that morphine has a strychnine-like effect on the spinal cord. It is occasionally seen in children. While this action is overshadowed in adults it is nevertheless present and makes morphine unsuitable as an antidote to strychnine. A still more important reason for not giving morphine in strychnine poisoning is its action on the respiratory centre, for death from strychnine is due to paralysis of that centre.

Minor Actions.—There are three somewhat important minor actions of morphine, the mechanisms of which are not well understood. It causes the pupil of the eye to contract and this is a means of detecting overdoses. It dilates the bloodvessels of the skin and tends to

start perspiration. Dover's Powder, a favorite mixture of opium and ipecac, is given for this action, but it is of little use unless accompanied by copious hot drinks. Whether given by mouth or subcutaneously morphine tends to check intestinal peristalsis. For this reason it is useful in peritonitis, diarrhea, and post-operative cases. In other cases this is a very annoying side action which is difficult to overcome. After morphine ordinary cathartics have little effect on the intestines. Morphine has no action on sensory nerve endings, and its application locally as dusting powder or in washes to relieve pain is irrational and useless. It seems in some way to decrease the excretion of sugar in diabetes and produces a general improvement in that disease.

Therapeutic Uses.—The therapeutic uses of morphine may be summarized as follows:

1. As a brain depressant to relieve pain and insomnia due to pain.
2. As a depressant of the medulla to relieve cough, quiet the heart, and check emesis.
3. To induce sweating.
4. To check peristalsis.
5. In diabetes to lessen excretion of sugar.

Untoward Actions.—The untoward actions of morphine are nausea, vomiting, constipation, and the tendency to form habit. In a recent investigation in a large city of the South morphine headed the list of drugs used by habitués, cocaine came next, then other forms or derivatives of opium, mostly laudanum and

heroin. Over 54 per cent. of the cases of drug habit were started by physicians' prescriptions.

Other Alkaloids of Opium.—There have been isolated from opium eighteen other alkaloids besides morphine, two of which are of some importance—**codeine** and **narcotine.** They are present in relatively small quantities. It was long believed that **narcotine** was the constituent of opium which was responsible for its nauseating effect, and for this reason opium deprived of this alkaloid, denarcotized or deodorized opium, was given preference. It is now known that this is not true. **Codeine** is obtained from opium or made synthetically from morphine. Codeine is less efficient than morphine to relieve pain and insomnia, but it is very good when only a mild action is desired. It is better for coughs because it is less depressing to the respiratory centre, less constipating, and less liable to form habit.

Heroin is a compound made from morphine by a chemical reaction between it and acetic acid. It resembles codeine in its action on coughs, but it is no better and should have no place in medicine because it is a dangerous habit-forming drug. Its use by habitués is favored by the fact that it is cheap and its dose is small, gr. $\frac{1}{20}$ (3 mg.).

Dosage.—Opium in the form of granulated opium contains about 12 per cent. of morphine. Therefore the dose of opium which is 1 grain (60 mg.) contains about gr. $\frac{1}{8}$ (8 mg.) of morphine. Preparations of *opium* are preferred to morphine for action on the gastro-intestinal tract.

Powdered opium,	gr. j	0.06 Gm.
Extract of opium,	gr. ss	0.03 Gm.
Tincture of opium (10 per cent.) (laudanum),	♏viij	0.5 Cc.
Camphorated tincture of opium (paregoric),	f℥ij	8.0 Cc. = morphine gr. $\frac{1}{10}$ (0.006 Gm.)
Powder of ipecac and opium (Dover's powder),	gr. viiss	0.5 Gm.
Morphine sulphate:		
1. To relieve pain,	gr. $\frac{1}{60}$–$\frac{1}{4}$	0.001–0.015 Gm.
2. To relieve cough,	gr. $\frac{1}{16}$	0.004 Gm.
Codeine sulphate,	gr. $\frac{1}{2}$	0.03 Gm.
Magendie's solution	♏v	0.03 Cc.

= morphine sulphate gr. $\frac{1}{6}$ (0.01 Gm.)
(Solution of morphine sulphate 1:30, 16 gr. to 1 ounce, or 1 to 30 Cc.)

Toxicology.—The symptoms of morphine poisoning are what may be expected from its action on the central system, contracted pupils, flushed face, slow heart, deep, slow breathing, and stupor. As morphine is excreted largely into the alimentary canal, whether given by mouth or by hypodermic injection, one method of eliminating it is to give repeated lavage with water or potassium permanganate and irrigation of the colon. The best physiological antidote is caffeine, pure or in the form of black coffee. Coffee may be given by mouth or by rectum, caffeine also by hypodermic injection. Strychnine and atropine should be avoided. Artificial respiration is most useful. The patient must be kept warm as the temperature usually falls as a result of the great depression. All efforts must be made to keep the patient awake.

Opium Habit.—The first bad effects from the opium or morphine habit are in the alimentary canal. At one time there will be chronic constipation, later chronic diarrhea; there may be for a while loss of appetite

followed by a voracious appetite. A person may take these drugs for years without showing symptoms noticeable to an ordinary observer. The pupils are contracted, the eyes dull, and the face after a time has a peculiar pallor. There are various nervous symptoms such as irritability, heightened reflexes and an irregular heart. Sooner or later the habitué loses flesh and develops low moral habits. A characteristic of this drug habit is a seeming lack of power to tell the truth. The habitué makes promises conscientiously, but does not and cannot keep them. The highest duties may make some appeal to him, but he has not the power to perform them. When a person reaches this stage he should be treated not as innately evil but as pitiably ill. A nurse must remember that such a patient is never to be trusted and will resort to all kinds of tricks to secure his drug. It is practically impossible to cure a morphine or opium habitué except in a special institution where he is totally removed from friends and hirelings. He may want to be cured but lacks the will-power to endure the suffering. The nurse, doctor, relative, or friend must supply that power by kind but firm guidance.

Alcohol.—Alcohol is the name of a class of organic compounds which contain the radical $-OH$, and in this respect may be compared with the inorganic hydroxides. The rest of the compound is composed of other radicals which are derived from hydrocarbons.

Hydrocarbon Series.—Hydrocarbons are compounds of hydrogen and carbon. Methane, CH_4 and benzene, C_6H_6, are examples. They exist in a number of series,

each series being named from its simplest member. The two series from which important medicines are derived run as follows:

Methane Series.	Benzene Series.
CH_4 = methane.	C_6H_6 = benzene.
C_2H_6 = ethane.	C_7H_8 = toluene.
C_3H_8 = propane	C_8H_{10} = xylene.
C_4H_{10} = butane.	— — —
C_5H_{12} = pentane.	— — —
— — —	— — —
— — —	$C_{12}H_{18}$
— — — —	
$C_{60}H_{122}$	

Hydrocarbon Derivatives.—From the methane series are derived the alcohols, and from the alcohols two other classes of compounds important in medicine, the *ethers* formed by dehydration and the *aldehydes* by direct oxidation. For example, by dehydrating methyl alcohol methyl ether is obtained; by oxidizing it formaldehyde is formed. From the benzene series most coal-tar products are obtained (see page 128). These numerous substances are all formed from the hydrocarbons by the substitution of some element or radical for one or more hydrogen atoms. For example the substitution of three atoms of chlorine for three atoms of hydrogen in methane forms chloroform, $CHCl_3$.

Radicals.—When one or more hydrogen atoms are thus displaced what is left of the original hydrocarbon is called the radical. Those given below remain after the displacement of *one* hydrogen atom. The names of the radicals are derived from the corresponding hydrocarbons and have characteristic endings.

HYDROCARBON.	RADICAL.
CH_4 = methane.	CH_3 = meth*yl* radical.
C_2H_6 = ethane.	C_2H_5 = eth*yl* radical.
C_5H_{12} = pentane.	C_5H_{11} = am*yl* radical.

Alcohols.—Alcohols are compounds in which the hydrogen has been displaced by one or more $-OH$ radicals, and are distinguished by the names of the hydrocarbon radicals which they contain.

CH_4 = methane.	CH_3OH = methyl alcohol.
C_2H_6 = ethane.	C_2H_5OH = ethyl alcohol.
C_5H_{12} = pentane.	$C_5H_{11}OH$ = amyl alcohol.

Methyl Alcohol.—Methyl alcohol (CH_3OH) is popularly called wood alcohol because it is obtained in commerce by the distillation of oak wood. Other trade names are Colonial and Columbian Spirits. *Methyl alcohol is one of the most dangerous poisons.* The use of it externally, internally, or the breathing of its fumes for a continued period causes permanent blindness by destruction of the optic nerve. Poisoning by methyl alcohol occurs largely as a result of the use of alcoholic beverages, popular medicines, and toilet waters which have been adulterated with it. It has exactly the same appearance and about the same odor as ethyl or grain alcohol which is used in medical practice. Attempts are being made to change the name to "wood spirit." Educational campaigns are in progress to spread a knowledge of its dangers and stringent laws are being passed to restrict its sale. At the time that the dangers of wood alcohol were first discovered, ethyl or grain alcohol was very expensive on account of an internal revenue tax imposed by the

Government. This tax was removed in 1906 from all alcohol to be used in the industries, provided it was denatured, that is, mixed with other substances which make it unfit for medicinal use. In **denatured alcohol** to every 100 parts of ethyl alcohol there are 10 parts of methyl alcohol and 0.5 of benzine or other chemical added to make the mixture nauseating.

Ethyl Alcohol.—Source.—Ethyl alcohol (C_2H_5OH) is popularly called grain alcohol because it used to be made by fermentation of grain. Now potatoes, rice, and other substances containing large amounts of sugar and starch are used in its manufacture. Other trade names are Rectified Spirit (95 per cent.), Proof Spirit (50 per cent.), and High Wine. Alcohol in the form commonly used in hospitals is 95 per cent. in strength; *dilute* alcohol is 49 per cent. *Absolute* alcohol, 99 per cent., has to be made by special processes and is not in common use.

Preparations of Alcohol.—Ethyl alcohol is used externally pure or diluted with water but internally in the form of various alcoholic preparations. The comparative strength of the more common ones is shown below.

Aromatic spirit of ammonia,	70 per cent.
Gin,	60–70 per cent.
Whisky (spiritus frumenti) Brandy (spiritus vini galli)	50 per cent.
Elixirs,	25–35 per cent.
Wines,	15 per cent.
Beers Ale Stout	3– 7 per cent.

Some of these preparations owe part of their activity to other constituents than the alcohol. The malted

beverages, such as beers, contain hops which are slightly hypnotic; brandy and red wines contain small amounts of tannic acid which exerts an astringent action on the intestines. Gin contains the volatile oil of juniper, an irritant to the kidneys, which is responsible for its diuretic action. Effervescing wines, such as champagne, owe much of their effect to the carbon dioxide which is a stimulant to mucous membranes. The ammonia in aromatic spirit of ammonia is itself a stimulant.

Local Action.—The action of alcohol when applied *locally* to the skin and mucous membranes is quite different from its effect after absorption. When applied to the skin it removes water from the epithelial cells and coagulates their albumin. If the alcohol is dilute the result is a mild stimulation, if it is strong, an antiseptic and astringent action. Therefore bathing with alcohol may be useful to stimulate the skin or to harden it according to the strength of the solution used.

Local Use.—The local stimulation of alcohol on the walls of the stomach improves digestion, increases the secretions and muscular movements, improves the appetite, and hastens the absorption of foods and medicines. For this purpose preparations not over 15 per cent. in strength must be used, for stronger solutions check ferment action. Wines and beers are the forms used as gastric stimulants. The astringent action of alcohol, in the form of brandy, is useful in diarrhea. If the antiseptic action of alcohol is desired in gargles or as a preservative it should be

used in about 60 per cent. solutions, as stronger ones coat the outside tissues with a film of hard albumin and prevent further penetration.

Systemic Action.—*Before Absorption.*—Besides the effect at the point of application strong alcohol, when locally applied to mucous membranes or to subcutaneous tissues by injection, has a marked and prompt

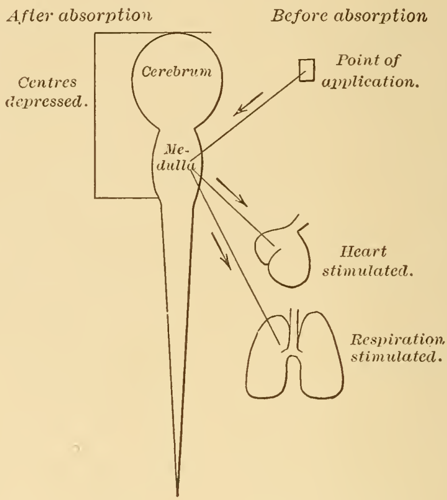


Fig. 6.—Diagram of action of alcohol.

reflex action on the central nervous system. There results an increase in the rate of the heart and respiration and a general feeling of warmth due to dilatation of the cutaneous bloodvessels (see Fig. 6). In this way alcohol gives very prompt results in fainting, collapse, and emotional shock. It is usually given in such cases in the form of brandy or whisky by mouth

or intramuscularly. Because of the tendency to produce a fall in blood-pressure later, other stimulants are preferred in severe surgical or traumatic shocks.

After Absorption.—When *alcohol is absorbed it acts on the central nervous system probably almost wholly as a depressant.* The familiar preliminary stage of excitement seen in these who indulge in liquors may be due to a brief stimulation of certain centres, such as those which control the function of speech, or to a depression of the centres of self-control. As a depressant, alcohol is used in medicine in insomnia and mild shock and to relieve nervousness and anxiety in fevers and heart disease. The use of alcohol as a stimulant in cases of poisoning and in prolonged illness is very much limited, if not contra-indicated, on account of its later depressing effect,

A Food.—Alcohol as a *food* has been a much-discussed question. It seems now agreed that a certain small amount is oxidized and the resulting energy and heat are used by the body in its normal processes. Alcohol, therefore, not in excess of the amount that can be oxidized, is useful in that it spares the fat and carbohydrate portions of ingested foods.

Phenol Antidote. — Alcohol is the most efficient antidote for phenol. For method of administration in cases of poisoning, see page 67. Phenol is more soluble in alcohol than in the tissue fluids and if it is removed quickly the tissues are restored to normal.

Therapeutic Uses.—The important uses of alcohol may be summarized as follows: (1) as an antiseptic (not over 60 per cent.); (2) as a stimulant or astringent

on the skin according to the strength used; (3) as a quick reflex stimulant in crises and emotional shock; (4) as an antidote to phenol. Minor uses are (1) as a stimulant to digestion and absorption; (2) as a nerve sedative; (3) as a food.

Disadvantages.—The disadvantages of the use of alcohol even in moderate amounts may be stated briefly as follows: (1) its tendency to form habit; (2) a decrease of mental efficiency; (3) a possibility of a serious fall of temperature, if taken before exposure to cold; (4) a predisposition to infection; (5) a decrease in muscular endurance. This seems sufficient argument against the use of alcohol as a beverage or as a medicine except in emergencies. Strong coffee is the best antidote to overdoses of alcohol in any form.

Movements against Use of Alcohol.—There are strong forces at work in the world today combating the use of alcohol as a beverage. The various prohibition societies are attacking the problem from a moral point of view; great corporations like the railways, the employees of which control human life, on the basis of inefficiency are not employing users of alcohol; the great nations of the world are enforcing prohibition in their armies and navies as a means of securing the highest degree of muscular endurance as well as of efficiency. In the United States the internal revenue office is endeavoring to check the use of medicated alcoholic preparations as beverages by levying a tax on their manufacture and sale. Any preparation, even if sold as a medicine, is subject to tax unless "it is sufficiently medicated to render it unfit for use as a

beverage." A recent list (June, 1914) contains 287 medicinal preparations subject to tax and includes all kinds of stomach bitters, tonics, cordials, and elixirs.

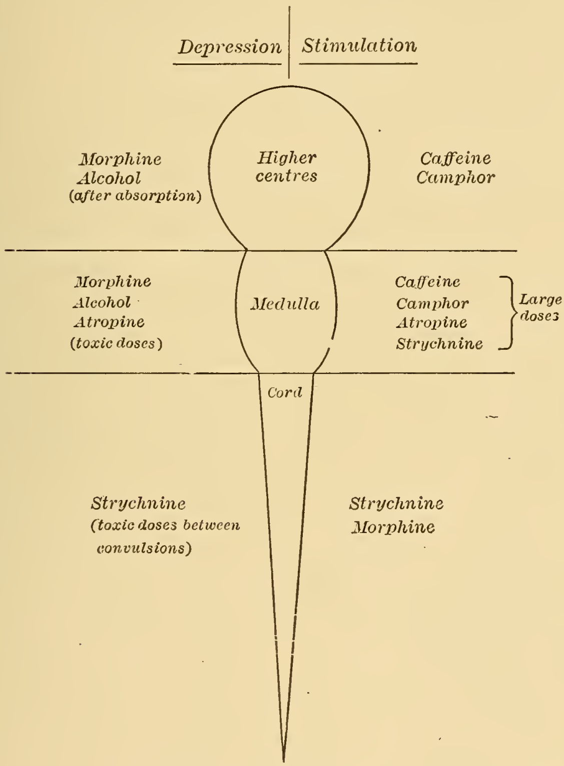


Fig. 7.—Comparative action of the central stimulants and depressants

These lists can be obtained from the Treasury Department at Washington, D. C. Evidence of the evils attending the use of this drug may be found in the

reports of institutions for the insane, the defective, the deformed, the epileptic, and the criminal. These show that the condition of a large percentage of the inmates is due to excessive use of alcohol either by themselves or their parents.

Hypnotics.

Hypnotics.—Hypnotics are medicines given to produce a condition resembling natural sleep. They are also called somnifacients and soporifics. These medicines, almost more than any others, should be used only as a last resort, for no hypnotic is known which is absolutely safe and which does not tend to produce a habit.

Action.—They produce sleep by directly depressing the brain centres. A therapeutic dose is one which depresses them just enough to cause a natural sleep. If this dose is exceeded the sleep passes to a stupor, the heart and respiration are depressed, and a condition results called **narcosis.** Narcosis is never sought in therapeutics but is a result of overdosing. The action of a hypnotic is much more effective if the patient is in a quiet state before its administration. To induce this state the nurse should make all external conditions favorable to sleep; place a hot-water bag at the patient's feet, give a light massage to reduce the blood supply of the brain, and relieve the patient's mind of worry and distracting thought.

Morphine.—Morphine, which has already been studied, is the great hypnotic of medicine, and is

practically the only one which will act in the presence of severe pain. Too much emphasis cannot be laid on the fact that morphine is a dangerous habit-forming drug. If wisely used it is one of mankind's greatest blessings; in careless hands it is a terrible curse. If insomnia is due to other causes than pain, such as nervousness or excitement, other hypnotics are always to be preferred.

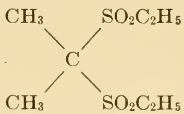
Chemical Hypnotics.—These other hypnotics are chemical compounds which owe their activity to some one constituent. They may be classified as follows:

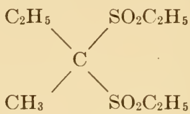
1. Those whose activity is due to a halogen: hydrated chloral, bromides.
2. Those whose activity is due to an ethyl radical: trional, sul phonal, tetronal.
3. Those whose activity is due to an aldehyde: paraldehyde.

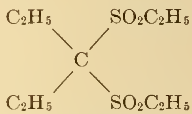
Hydrated Chloral. — Hydrated chloral ($C_2HCl_3O + H_2O$) is a white crystalline substance which on exposure to light and air changes to chloral, a highly toxic compound. For this reason it must be kept in well-stoppered amber-colored bottles. As a hypnotic it acts quickly, usually in less than an hour, and its effects are fairly lasting. Hydrated chloral has the reputation of being more dangerous than other hypnotics, but in ordinary doses it is relatively safe. In large doses it is distinctly dangerous, because it directly depresses the heart muscle and causes alarming heart symptoms. For this reason in cases of poisoning by chloral the patient must be kept absolutely quiet to prevent any strain on the heart. Somnos, somnal and bromidia are proprietary remedies which owe their activity to hydrated chloral.

Bromides.—There are seven official bromides, the most important being **sodium** and **potassium bromides.** There is a common preparation called triple bromide which contains these two and ammonium bromide. Dilute hydrobromic acid has the same action. The bromides are all white or colorless salts with a bitter or salty taste. Their chief use is as nerve sedatives, but in insomnia not due to pain they are useful as hypnotics. In the presence of pain such large doses are required to produce sleep that they also depress the heart and respiration and under those conditions may be unsafe.

Ethyl Hypnotics.—In this group are **sulphonal, trional, tetronal, veronal** and **medinal.** To a large extent these hypnotics are alike in their degree of action. The similarity of their composition is shown in the graphic formulæ of the first three.


Sulphonal.


Trional.


Tetronal.

Veronal is an ethyl hypnotic of complex composition derived from urea. *Medinal* is a sodium salt of veronal, the purpose of the combination being to obtain a more soluble compound. *Sulphonal* is official in the greatest number of pharmacopeias. The ethyl hypnotics are slow in action, requiring about two hours to produce sleep. The prolonged use of them is highly dangerous as they may suddenly cause collapse which in about 50 per cent. of the cases is fatal. If

sulphonal is being used continuously the urine should be examined frequently for hematoporphyrin, one of the decomposition products of red blood corpuscles. Its presence is a positive warning of danger.

Paraldehyde.—Paraldehyde is a colorless liquid with a pungent, disagreeable odor and taste which very much limits its usefulness. It acts in about thirty minutes and in most cases is efficient.

Administration.—Hydrated chloral: gr. v-xx (0.3–1.3 Gm.). Bromides: as nerve sedatives, gr. xx (1 Gm.); as hypnotics up to gr. xxx (2 Gm.). Sulphonal, trional, and tetronal, gr. xv (1 Gm.); veronal and medinal, gr. v (0.3 Gm.). Paraldehyde: ♏xxx (2 Cc.).

Hydrated chloral and the bromides are irritating to the stomach and should be given well diluted in water or milk. Hydrated chloral may be given on cracked ice. Paraldehyde should be given in ice-water or on cracked ice or with some aromatic to disguise the taste.

It is easier to induce a person to sleep at his normal time for retiring, and hypnotics are best given so that they will act at that time. For example, if it requires two hours for one to act, it should be given two hours before the patient is expected to sleep.

Some people are very susceptible to the action of the bromides and suffer from headaches, skin eruptions, and cyanosis after their administration. These symptoms would indicate a reduction in the dose or the discontinuance of the drug. If some hypnotic must be used over a long period the danger of habit formation may be obviated by using different drugs for a short time.

Toxicology.—For poisoning by morphine, see page 106. If poisoning by the other hypnotics is discovered early remove them at once from the stomach by lavage. If depression has already set in, give cathartics and use general measures of stimulation with caffeine as the physiological antidote. Keep the patient very quiet, as any exertion on his part may cause heart failure.

General Anesthetics.

Definition.—An anesthetic is a drug given to produce immobility and insensibility. A **general anesthetic** causes this condition over the whole body usually with loss of consciousness; a **local one** produces it in some limited area at the point of application.

History.—In ancient times the Egyptians, Hindus, and Chinese used for anesthesia some narcotic drug which was given by mouth. In the middle ages opium and hyoscyamus were tried and often alcoholic liquors were given until the patient was in a stupor. Ethyl ether, which is in such common use at the present time by inhalation, was known as a chemical compound 300 years before its use as an anesthetic. About 100 years ago the inhalation of ether was a fad and ether parties were in vogue. In 1842 a doctor in Georgia, Crawford Long, at one of these parties noticed that while under the influence of the drug sensibility to pain was much decreased. He commenced using it in his medical practice but did not spread the knowledge of his discovery. In 1846 Dr. Morton, of Harvard Medical School in Boston, popular-

ized its use in surgical operations and he is generally accredited with the discovery of its anesthetic action. Chloroform was discovered as an anesthetic the next year and nitrous oxide shortly afterward. These three compounds and ethyl chloride are the general anesthetics now in common use.

Description.—Ethyl ether is one of the class of compounds called ethers which are made from alcohols by dehydration.

$$\begin{array}{l} C_2H_5OH \\ C_2H_5OH \end{array} \rightarrow (C_2H_5)_2O + H_2O$$

Ethyl alcohol. Ethyl ether.

Ethyl ether is sometimes spoken of as sulphuric ether because sulphuric acid is the dehydrating agent used in its manufacture. It is highly inflammable. In chemical nomenclature **chloroform** is trichlor-methane, the name indicating its composition.

$$\underset{\text{Methane.}}{CH_4} + \underset{\text{Chlorine.}}{3Cl} \rightarrow \underset{\text{Chloroform.}}{CHCl_3} + 3H$$

Nitrous oxide (N_2O) is a gas popularly called "laughing gas," used very generally by dentists for the extraction of teeth. This gas combined with oxygen is now employed almost exclusively as an anesthetic in some hospitals. A special apparatus is used by which the two gases are mixed and the proportion varied as desired.

The composition of **ethyl chloride** (C_2H_5Cl) is indicated by its name. It is a colorless inflammable liquid which easily vaporizes. For general anesthesia the vapor

is conducted into an inhaler. For local use it is kept in glass tubes which have a minute opening at one end covered by a metallic cap. When the cap is removed the liquid escapes in a fine spray. If one of these tubes is held for some time in the hand, the heat of the hand is sufficient to vaporize the liquid inside and burst the tube. Nitrous oxide, chloroform, and ethyl chloride produce anesthesia very promptly, in from 2–5 minutes; ether requires from 8–15 minutes.

The Anesthetist.—The administration of anesthetics is now recognized as an art and doctors and nurses are specializing in this work. Not only is skill required in the actual anesthetization but in the choice of the anesthetic, for age, temperament, habits of sobriety, the condition of the heart, lungs, and kidneys are all factors which must be considered in its selection. The legal status of nurse anesthetists is still under discussion. There is at present no law prohibiting others than registered physicians from giving an anesthetic, but it has been contended by certain courts that this act constitutes practice of medicine, hence would be illegal if performed by a nurse.

Methods of Administration.—For a number of years the only method of general anesthesia was by direct inhalation of ether or chloroform. There are so many disagreeable side actions and after-effects from these that in recent years attempts have been made to devise other methods. Various mixtures of ether, chloroform, and alcohol by inhalation have been tried. Ether and chloroform have been given intravenously, ether vapor given by a tube inserted into the trachea (intra-

tracheal insufflation) and by rectal injection, cocaine and stovaine by injection into the spinal canal, morphine and scopolamine by subcutaneous injection. Some one of these methods of anesthesia may be popular in certain hospitals, but no one has as yet been so successful as to gain general favor.

Stages of Anesthesia.—There are four stages in anesthesia by the inhalation of ether and chloroform, three of them practically always seen, the fourth a danger stage always to be avoided.

First Stage.—The first stage is one of local irritation. Ether and chloroform are both highly irritating to mucous membranes, and chloroform is liable to burn the skin if in full strength or in a concentrated vapor. This action causes most annoying conditions as coughing, choking, weeping of the eyes, and an increased flow of saliva.

Second Stage.—The second stage is characterized by excitement. It is practically eliminated by chloroform, the full effect of this anesthetic being reached so quickly. The excitement is probably due to an early paralysis of the centres of self-control. It is during these two stages that death sometimes occurs, especially with chloroform, for in a desire to pass them over as soon as possible the anesthetic is given very strong and the concentrated vapor in the blood paralyzes the heart.

Third Stage.—The third stage is called the stage of surgical anesthesia. Sensation, mobility, consciousness, and the reflexes, except one, are lost by a paralysis of the brain centres. The reflex of the cornea of the eye

is the last to be affected, and should be retained during this stage. The failure of the cornea to respond to the touch is a sure sign of danger. The centres in the medulla are also depressed to a certain extent, so that the respiration and pulse are slow and full. The pupil of the eye is contracted.

Fourth Stage.—The fourth stage is the result of an overdose of the anesthetic. The centres of the medulla are so greatly depressed that the respiration and pulse are irregular, the reflex of the cornea is lost, and the pupil dilated. In recovery from an anesthetic a patient passes through these same stages in a reverse order.

After-effects.—While the muscles of the neck and throat are relaxed during anesthesia saliva passes down the esophagus into the stomach. This is saturated with ether vapor which irritates the stomach and causes postoperative vomiting. Another distressing after-effect is an abnormal formation and accumulation of gas in the intestines. There are various disorders of the respiratory tract following anesthesia, the chief one being "ether pneumonia." This may be due to an irritation of the lungs by the anesthetic or to the inhalation from the mouth of some germ which gains a foothold while the lungs are in a condition of lowered resistance. An acute nephritis, degeneration of some of the organs and paralysis of the stomach and intestines are other serious after-effects which may occur several days after anesthesia.

Preparation of Patient.—There are a few routine essentials in the preparation of a patient for anesthesia which apply to all cases. The patient must be clean, the

hair tightly covered and, in case of a woman, tightly braided, the alimentary canal and bladder must be empty and all removable articles, such as jewelry and false teeth, taken away. The kind of clothing and exact method of procedure in emptying the alimentary canal vary in different hospitals. It must be remembered that

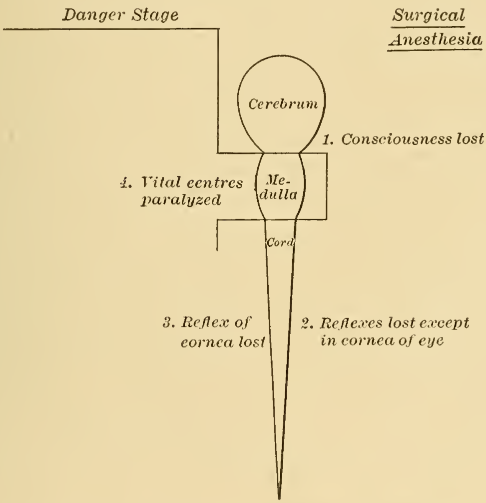


Fig. 8.—Diagram of important factors in anesthesia. Numbers indicate the order in which the effects appear.

it requires strength to endure the ordeal of an operation, and a patient should not be weakened unnecessarily by being deprived of food too long before anesthesia. A calm state of mind before an operation has been shown to be an important factor in lessening shock. A nurse can do much to reassure her patient and frequently sedative drugs are given shortly before

anesthesia. Morphine sulphate is the most commonly used; morphine and scopolamine or chloretone, a central depressant, may be used. Atropine sulphate is frequently given with morphine, the purpose of which is to lessen the secretion of saliva, to stimulate the respiration, and to prevent excessive stimulation of the vagus. It has been learned very recently that nearly every anesthesia causes acidosis, a condition in which acetone and various acids are present in the blood and urine. As preventive measures for this condition carbohydrates, such as sugar or a light, well-sweetened meal, are given about four or five hours before anesthesia, and a rectal injection of sodium bicarbonate one-half hour before.

Comparison of Ether and Chloroform.—The immediate dangers of ether are much less than of chloroform, but if statistics were collected showing deaths by after-effects it is a question which would have the advantage. There are many fatalities from the effect of ether on the respiratory tract and kidneys. Chloroform, on the other hand, is very depressing to the heart during its administration and tends to cause fatty degeneration of the liver and heart some days later. The preliminary and postoperative discomforts are much less with chloroform than with ether. Ether is highly inflammable, chloroform is not. The margin of safety during a prolonged anesthesia is greater with ether, while chloroform is to be preferred for examinations and short operations. Resuscitation from ether poisoning is quite frequent, even when the heart has stopped beating; resuscitation from chloroform is infrequent.

Comparison of Ether and Nitrous Oxide.—Nitrous oxide administered with oxygen practically eliminates the discomforts of the first stage under ether and causes very much less postoperative nausea. The margin of safety under the mixed gases is much greater than with ether. Nitrous oxide is very quickly eliminated and is followed by practically none of the later complications seen after ether. Its chief danger in long anesthetizations is from asphyxiation but when properly given this is not considerable.

Dr. Crile of Cleveland, Ohio, who has won fame by the results of his studies of shock and the performance of shockless operations, prefers nitrous oxide and oxygen to ether as an anesthetic in the belief that nitrous oxide tends to check brain activity while ether does not. He believes that excessive activity of the brain cells caused by floods of stimuli from the seat of the operation leads to their exhaustion and that this causes shock.

Analgesics.

Analgesics are drugs given for the purpose of preventing or reducing pain.

Morphine, Codeine, Hyoscyamus.—**Morphine sulphate** stands above all other drugs as an analgesic. It is given in doses of gr. $\frac{1}{8}$–$\frac{1}{4}$ (0.008–0.015 Gm.) according to the intensity of the pain. Habit formation is its greatest danger, especially with patients of a nervous temperament. **Codeine sulphate** gr. $\frac{1}{2}$ (0.03 Gm.) is a good substitute when only a mild action is needed. **Hyoscyamus** in the form of a tincture is

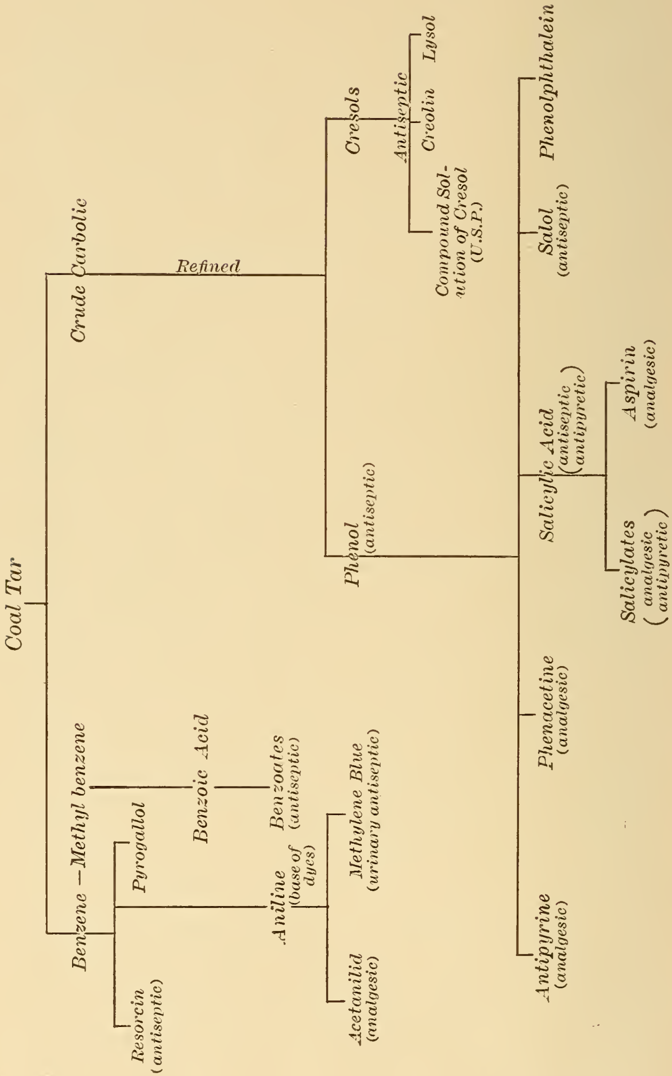


Fig. 9.—Diagram of coal-tar derivatives.

frequently used with children or in mild treatment for adults. The adult dose is 30 minims (2 Cc.).

Coal-tar Analgesics.—The coal-tar products, acetanilid, antipyrine and phenacetine, constitute a group of remedies for the relief of minor pains and especially headaches. These are called coal-tar products because they are made from coal tar (see Fig. 9). They really are by-products from the manufacture of coal-tar dyes.

Action.—These remedies are all *powerful central depressants* which show their effect chiefly by quieting neuralgic pains and slowing the heart. When they were first discovered about thirty years ago they were used exclusively to reduce temperature in fevers. With better knowledge of the nature of fever this action was recognized as undesirable in many cases. Their use was then restricted to quieting headaches and other nervous conditions, but so many bad results have been reported, such as cyanosis, depression and failure of the heart and formation of the drug habit, that doctors are prescribing them less and less for any purpose.

Therapeutic Uses.—The chief uses of the coal-tar analgesics in therapeutics are as follows:

1. As antipyretics to reduce temperature in certain types of fever (page 214).

2. As analgesics to allay pain, chiefly headache and neuralgic pains.

Proprietary Preparations.—Patent medicine manufacturers have spread the use of these drugs widely by advertising mixtures of them under trade names for headaches, colds, grippe and about every pain

known to man. Shortly after the passage of the Food and Drugs Act the United States Department of Agriculture suspected that many of these mixtures were not being properly labelled, and made an investigation of the extent of their sale, use, and dangers.[1] Since that time the American Medical Association has carried on extensive investigations and the results are appalling, both in the great number of proprietary preparations of these dangerous drugs and in the clever advertising to conceal their exact nature and to attract unsuspecting sufferers.[2] *Antikamnia*, a popular headache remedy, contains in every ninety-eight parts, sixty-eight parts of acetanilid. *Orangeine* contains more than half acetanilid, *phenalgin* still a greater proportion. *Hick's Capudine* depends upon antipyrine and salicylates for its activity. Still these are all advertised as safe, without "dope," and in some cases to be taken freely.

Habit Formation.—In the investigation by the United States Department of Agriculture 400 physicians reported 814 cases of poisoning, 29 deaths and 136 cases of habitual use of these drugs, and in a large majority the remedy was taken for headache. In regard to habit formation, the following conclusion is given in the bulletin: "The ache or pain for which the medicine was first taken is often worse than ever after the effects of the remedy have passed away,

[1] The results of this investigation were published in Farmer's Bulletin, 377, The Harmfulness of Headache Mixtures.

[2] The book, Propaganda for Reform in Proprietary Medicine, published by the American Medical Association exposes these and many other frauds in medicine.

because of the weakened condition of the system which may result from the use of these agents, and hence there is additional call for the remedy. Thus a habit may be established—more drug, impaired bodily health, lessened resistance, more pain, more drug."

Comparative Effects.—Acetanilid and antipyrine are considered more dangerous than phenacetine, but the latter is by no means safe as 17 of the reported cases of habit formation were from that drug. **Aspirin** is a coal-tar derivative (see Fig. 9), which was supposed for a long time to be a safe substitute for the coal-tar remedies described above. Recently reported cases of poisoning have been on the increase and it, too, seems to be not without danger. **Pyramidon** is a still newer compound which is closely related chemically to antipyrine. It is claimed to have a more lasting analgesic effect and to be harmless to the heart. All coal-tar analgesics are as safe in small doses as any powerful depressant but they should be used with a full knowledge of their dangerous character.

Administration.—In headaches if a small dose of one of this group of drugs is not effectual, it is a fairly good indication that some other kind of medicine is needed for that type of headache. Repeated and increased doses to obtain a result are useless and unsafe. The average doses are as follows:

Acetanilid,	gr. iij	(0.2 Gm.)
Phenacetine,	gr. viiss	(0.5 Gm.)
Antipyrine,	gr. iv	(0.25 Gm.)
Aspirin,	gr. v–xv	(0.3–1 Gm.)

Attempts are made to offset the untoward effects of these drugs by giving others in combination with them. Theoretically caffeine would offset their depressant action on the heart, and for this reason it is combined with acetanilid in **Compound Acetanilid Powder** (U. S. P.), a headache remedy. Recent studies have shown that caffeine tends to increase rather than decrease the toxicity of acetanilid, and many fatalities have been reported from the use of this powder. Sodium bicarbonate does seem to lessen the toxic effect of the coal tars on the heart. Strychnine is sometimes given to counteract the general depression and atropine to control any excessive sweating which may result.

Toxicology.—Besides excessive sweating some people suffer from eruptions after administration of these drugs. The characteristic symptom of overdosing is cyanosis. In small doses this may be noticed only on the lips or under the nails. In large doses it may be apparent all over the body. It is due partly to the depressed heart action and partly to an alteration of hemoglobin in the red blood corpuscles. In severe cases and in chronic poisoning the corpuscles are themselves destroyed and anemia results. Other symptoms of poisoning by large doses are burning of the whole alimentary canal, coldness of the extremities, various nervous symptoms, and collapse. Demulcents and general stimulation are indicated in treatment of poisoning.

ACTION ON THE PERIPHERY.

Local Anesthetics.

Local anesthetics, as already stated, are medicines which produce anesthesia at the point of application. The most important local anesthetic is **cocaine.**

Cocaine.—Cocaine is an alkaloid derived from the leaves of erythroxylon coca, a small plant which grows on the slopes of high mountains in Peru, Ecuador and Bolivia. The history of coca is the history of Peru, as the ancient peoples considered it the living representative of their deity and the ground where it grew sacred. The natives of those countries at the present day make a practice of chewing coca leaves daily to give them strength and the power to endure hunger and fatigue. The results are wonderful but for some reason in other climates they cannot be secured. There must be some constituent of the leaves unknown to science which produces these effects, for the native chewers carefully select leaves which are not rich in cocaine and they do not acquire the cocaine habit.

Local Action.—The alkaloid, cocaine, was discovered in 1860. It was noticed at that time that it produced numbness when placed on the tongue but no practical application was made of this discovery until 1884. Cocaine has no effect on the unbroken skin but when placed on mucous membranes, in the eye, or injected into subcutaneous tissue it causes *paralysis* of the *sensory nerve endings* and *constriction* of the *capillaries*

and small arteries (see Fig. 11, page 138). The result is a bloodless anesthetized area around the point of application, an ideal condition for minor operations. Anesthesia is produced in about five minutes and lasts about a half-hour.

Fig. 10.—Cocaine plant. Growing in the New York Botanical Garden, Bronx Park, New York City.

The constriction of the arteries is an advantage also because it prevents too rapid absorption of the cocaine. If the drug is taken into the blood too quickly the local action does not last and undesirable systemic effects are produced. If, however, the constriction is too great and the drug remains a long time in the tissues

unabsorbed, it is liable to destroy them. This explains a certain proportion of cases of abscesses and gangrene following the administration of cocaine. A physician then must regulate the dose so as to avoid too rapid absorption on one hand and too slow absorption on the other.

Systemic Action.—If any considerable amount of cocaine is absorbed it *stimulates the brain* like caffeine, causing a condition of excitement and wakefulness. *Larger doses stimulate the medulla,* affecting chiefly the vasomotor centre and producing a rise in blood-pressure. This is a striking symptom of poisoning by cocaine. It also causes more rapid heart action and respiration and a general feeling of well-being. The period of stimulation and excitement is followed by depression and in some cases by sudden collapse. Cocaine is practically never given for its systemic action but some very susceptible people get the systemic effect by absorption from local treatments.

Other Uses.—In eye surgery cocaine is quite indispensable. Besides causing anesthesia it dilates the pupil. When cocaine is injected into the spinal canal for surgical operations it paralyzes the sensory nerve cells there, and causes general insensibility below the point of injection. In inflammatory conditions of the pharynx and nose cocaine acts as an astringent to reduce swelling and irritability. It is particularly efficient in checking capillary hemorrhage.

Administration.—The common form of this drug for local application is **cocaine hydrochloride** in solutions from 2–10 per cent. in strength. They do not keep

well and cannot be repeatedly boiled for sterilization. A safe dose of this drug internally is about ½ grain (0.03 Gm.). The **wine** and **fluidextract** of **coca** are occasionally used to check emesis due to a local irritation, and to relieve pain from ulcers of the stomach.

Substitutes.—Various substitutes have been prepared in an attempt to find an efficient local anesthetic which will not spoil in solution and which has no dangerous after-effects. Stovaine, eucaine, novocaine, tropacocaine, all chemically related to cocaine, are examples of these, but cocaine still remains the most reliable under all circumstances.

Toxicology.—Whenever cocaine is used locally the possibility of too great absorption must always be borne in mind. Some of the symptoms of absorption are headache, dilated pupils, nausea, palpitation of the heart, insomnia and even sudden collapse. If an overdose has been taken by mouth and early treatment is possible, give the usual first-aid treatment for alkaloid poisoning. All other treatment is symptomatic. In the excitement stage apply an ice-bag to the head, keep the head low, and use every means to calm the patient's mind. The doctor will probably order bromides or some other mild sedatives. This stage is seldom dangerous and care must be taken not to increase the depression which is sure to follow. When depression begins, direct all treatment to stimulation of the respiratory centre. A nurse can give artificial respiration if convulsions are present. Strychnine and caffeine are the physiological antidotes. Caffeine, according to some authorities, tends to increase the

effect of the poison in some cases and should be avoided.

Habit.—The cocaine habit is more easily formed than that of morphine. It is not uncommon among nurses, doctors, and druggists. An habitué lacks self-control, is melancholy and languid, and has very low standards of living, physically, mentally, and morally.

Quinine and Urea.—A new local anesthetic is **quinine and urea hydrochloride**, also called bimuriate of quinine and urea. It is given subcutaneously in saline solutions about $\frac{1}{4}$ of 1 per cent. in strength. Stronger solutions interfere with healing processes. The action is prompt and continues for several hours. Quinine salts are not very soluble and when injected subcutaneously alone are highly irritating. This double salt is easily soluble and well adapted to hypodermic use.

Ethyl Chloride.—Ethyl chloride (kelene, a trade name,) is used to some extent as a local anesthetic (page 121). It is sprayed directly on the field of operation, and by its very rapid evaporation freezes the tissues thus causing insensibility.

Anodynes.

In this classification of drugs an anodyne is considered a drug which is applied *locally* to relieve pain, in distinction from an analgesic which acts *systemically*. It is sometimes defined as a mild analgesic. Anodynes usually produce their effect by paralyzing the sensory nerve endings. Pain is often easily relieved by removing the cause; at other times by means of a counter-irritant. In some cases, however, local applica-

tions of drugs are necessary until conditions can be adjusted.

The important anodynes are **atropine, aconite, menthol, camphor, and methyl salicylate. Atropine** (see Fig. 11) is used for its local action chiefly in the form of a belladonna plaster. **Aconite,** a drug which will be studied under the circulatory system

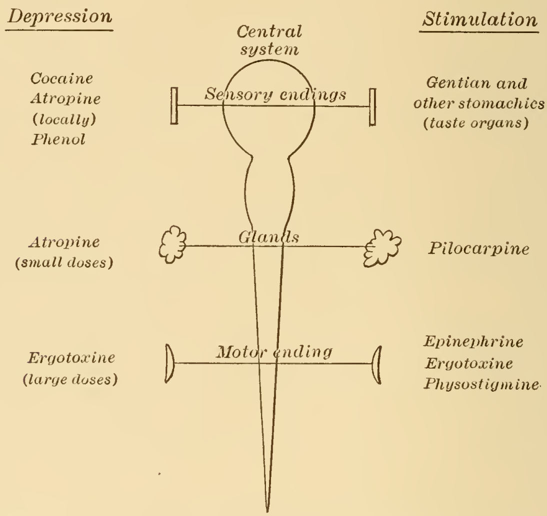


FIG. 11.—Diagram of drugs which act on the periphery.

page 157), is applied locally in the form of a tincture to relieve the pain of neuralgia. The tincture should never be applied to mucous membranes because it is readily absorbed from them and causes dangerous heart symptoms. **Menthol** is a substance chemically allied to camphor which is obtained from the oil of peppermint. Its name is derived from the first part

of the botanical name of peppermint, mentha piperita. Menthol, in the form of pencils, is rubbed on the skin or inhaled for headaches. It has a mild action but is very acceptable because it is followed by a sensation of coolness. **Camphor** has a similar action. Menthol and camphor are common ingredients in solutions, liniments, and ointments, and may be taken internally for gastric pains. Menthol is contained in many proprietary remedies such as Anodyne Balm, Analgesic Balm, Baume Analgesique Bengue, Antineuralgic Ointment, and Analgesic Cream.

Methyl salicylate as an internal remedy has the specific action of salicylates in rheumatism (page 223), but when applied locally it is an anodyne. It is a synthetic compound, an aromatic and almost colorless liquid, which is practically identical with the oil of wintergreen (gaultheria) and the oil of birch (betula). Methyl salicylate or the natural oils, alone or in liminents, may be applied locally to relieve pain in inflamed nerves or rheumatic swellings. As these substances are absorbed quite readily from the skin, local applications may produce typical salicylate action.

Mydriatics and Myotics.

Mydriatics are drugs which produce dilatation of the pupil of the eye; **myotics** produce contraction. As has already been seen, some drugs produce one or the other of these effects in the eye when used internally for other purposes, such as morphine and atropine. When the actions are desired in eye treatments the drugs

are prepared in solution and dropped directly into the eye.

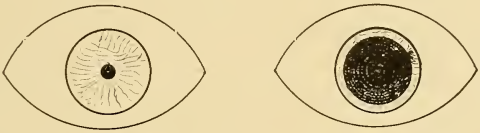
Action.—There are two sets of muscles which regulate the size of the pupil of the eye; the circular, the function of which is to keep the pupil small and the radial which has the opposite function. The size at any one time depends on the balance between the two sets. A drug may cause a change in its size by acting on these muscles themselves or on the endings of the nerves which control them, usually the latter.

Mydriatics.—Mydriatics are used (1) in examinations of the eye to enable the examiner to see the interior portion; (2) to rest the muscles; (3) to check a spread of inflammation; and (4) to prevent the formation of adhesions. Other mechanisms are often affected by the same drugs. Some, for instance, paralyze the accommodation of the eye, that is, its power to adjust its focus on near and far objects. This action is solicited when glasses are to be fitted.

Atropine sulphate is a mydriatic which also paralyzes the accommodation. These conditions are produced to their full extent in about two hours and last from a few days to two weeks. The prolonged effect makes it undesirable for diagnostic purposes, but very useful in controlling inflammation and preventing adhesions. A 1 per cent. solution is commonly used. **Homatropine** is an artificial alkaloid chemically allied to atropine. Its hydrobromide is the salt usually used. It has the same effect as atropine on the eye but is more prompt in action and the effect is more fleeting. It is preferable, therefore, in eye examinations and in fitting of glasses. It also is used in a 1 per cent. solution.

Scopolamine in very weak solutions (0.2 per cent.) is similar in action to the two previous drugs. It is very prompt and is claimed by some ophthalmologists to be less irritating than atropine. The hydrobromide is used.

Myotics.—Myotics are used alternately with mydriatics to break up adhesions and to restore the natural condition of the pupil after examinations. An important use of myotics is in the treatment of a



Following internal adminis-tration.	*Morphine* *Ether (3rd stage)*	*Cocaine* *Ether (4th stage)* *Atropine and allied drugs.*
Following drops in eye.	*Physostigmine* *Pilocarpine*	*Cocaine* *Atropine and allied drugs.* *Homatropine.*

Fig. 12.—Common drugs which affect the size of the pupil of the eye.

common disease of the eye called glaucoma. One characteristic of this disease is a very high tension of the fluids inside the eyeball (intra-ocular tension). This may be decreased by lessening the secretion of the fluids and by keeping open the channels of their escape. As the exits are covered when the pupils are dilated, myotics are indicated.

Physostigmine.—Physostigmine, the most important myotic, is an alkaloid derived from physostigma, a bean plant resembling our lima bean. It is commonly known as Calabar bean, Calabar being the name of

a town in Africa in the region where it grows. The alkaloid is recognized in the French Pharmacopœia as **esérine**, and the two names are used interchangeably in this country.

This drug is a deadly poison and used among the natives of Africa as a test for witchcraft. If the suspected person dies after eating the beans, that is considered proof that he is guilty; if not, he is thought innocent. The guilty, however, have ways of avoiding the action of the drug and survive while the innocent die. In ophthalmology physostigmine salicylate is a most valuable myotic. Its action begins in a few minutes and continues over several days. It sometimes causes disagreeable twitching of the eye muscles which make it not altogether desirable in counteracting the effect of mydriatics. It is used in 0.5 per cent. solutions.

Pilocarpine.—Pilocarpine is an alkaloid obtained from the leaves of a low shrub of Brazil called pilocarpus or Jaborandi. Pilocarpus has a stimulating effect on the scalp, and in formulæ for hair tonics the term Jaborandi is usually used. This drug is an important one for its action on sweat glands. (See Diaphoretics, page 200). As a myotic pilocarpine hydrochloride is used in from 0.5–1 per cent. solutions. It is weaker in action than physostigmine but is used for the same conditions. Physostigmine is usually preferred.

ANTISPASMODICS.

As the name implies antispasmodics are medicines given to prevent or relieve spasms. Disorders which are

spasmodic in nature are hysteria, epilepsy, hiccoughs, asthma, convulsions of pregnancy, spasms of the heart in angina pectoris, headaches caused by spasms of the arteries, coughs, and the cramps of menstruation. With such a range of disorders there would be necessarily many remedies acting in a variety of ways. Some of these conditions are due to overstimulated muscles, some to overstimulated nerves, and some to a lack of inhibitory control of the muscles by the nerves.

Depressants.—The group of medicines which are antispasmodic by depressing overstimulated muscles, the nitrites, will be studied in the next chapter. Those which quiet overstimulated nerves are the central nerve depressants, morphine, scopolamine, hydrated chloral, and the bromides and the peripheral depressant, atropine.

Stimulants.—The stimulating antispasmodics are **oil of peppermint, capsicum, asafetida, valerian, and Hoffmann's Anodyne.** The first two relieve spasmodic conditions by their actions as carminatives (page 185).

Asafetida and Valerian.—As the active principles of asafetida and valerian are volatile oils they also are carminative but their action in hysteria, for which they are most valuable, is due largely to their odor. To most people the odor is very repulsive, but to one in a hysterical state it not only is often pleasing but by some psychic influence it stimulates the higher nerve centres. These two drugs are often termed antihysterics. The official preparations of **valerian** are the tincture, fluidextract, and the **ammoniated tincture.** The last, the most commonly used, is made by extract-

ing the drug with the aromatic spirit of ammonia, a synergistic remedy. Its dose is 30 minims (2 Cc.). **Asafetida** is a gum resin from Asia and is there valued as a condiment. The preparations most used are the **pills** (dose 2–3) and the **emulsion,** dose $\frac{1}{2}$–1 ounce (15–30 Cc.). It may be used as an enema for flatulence in the proportion of 2 grains to 4 fluidounces of water (0.1 Gm.–120 Cc.).

Hoffmann's Anodyne.—Hoffmann's Anodyne is the Compound Spirit of Ether, the ether being in the proportion of 33 to 65 of alcohol. Its medicinal action then is due as much to alcohol as to ether. Its special value is in relieving spasmodic conditions due to distention of the alimentary canal, such as dyspnea, heart symptoms, and colic of the stomach or intestines. In these conditions the anodyne acts by removing the cause. Both ether and alcohol, by stimulation of the mucous membrane, cause the expulsion of the gas, and alcohol by reflex action stimulates the heart and respiration.

Administration.—The dose of Compound Spirit of Ether (Hoffmann's Anodyne) is 1 dram (4 Cc.). There are several facts in regard to this preparation which are important for a nurse to remember. It is inflammable, it is highly irritating, it has a very bad odor and taste, and the eructations of gas following its use taste of ether. It must therefore be kept away from an exposed flame; it must be given very dilute and on cracked ice or sugar, and every possible measure taken to relieve the patient of the taste and odor of ether after the drug begins its action.

CHAPTER XII.

MUSCULAR SYSTEM.

THERE are no medicines which act directly on *voluntary* muscles. The only way in which their condition can be improved is by general tonics, physical exercise, and massage. There are a few which act on *involuntary* muscles causing them to contract or to relax. Upon the involuntary muscles depends very largely the condition of one entire system of the body, the circulatory system, and by giving drugs which act on these muscles important changes can be brought about in that system. For example, drugs which improve the tone of the heart muscles increase the force of the heart beat; drugs which cause the muscles in the walls of the arteries to relax lower blood-pressure and increase the rate of the heart. There are also drugs which act on the muscles of the uterus and of the intestines.

The important medicines which are known to act directly on muscle tissue are **digitalis**, **strophanthus**, and **the nitrites**, all of which affect the circulatory system, and **pituitary extract** which also acts on the uterus. A less important one is **physostigmine**, used as a myotic and sometimes as a cathartic.

MUSCLE TONICS.

Digitalis and Strophanthus.—**Source.**—These two drugs are so similar in action that they will be con-

sidered together. Strophanthus is by far the more toxic of the two. The drug, digitalis, is the powdered dried leaves of the well-known plant, digitalis or foxglove. The supply for medicine comes chiefly from Europe. Strophanthus is the seed of a native plant of Africa which is used there as an arrow poison.

FIG. 13.—Digitalis plant. Grown in the school garden at Teachers College, New York City.

Review of Structure and Action of Heart.—The action of these drugs is comparatively simple if the anatomy and physiology of the heart are understood. It is probable that in *therapeutic doses* they act wholly on the heart itself, little on the nervous system, and none at all on the arteries.

From the study of Physiology it is learned that all muscles in a normal state have **tone**, a maintained degree of contraction, the **power of irritability**, that is, of receiving stimuli from the nerves, and the **power of contractility**. The muscle fibers of the heart have the power of *rhythmic* contraction, manifested in the beat of the heart. The original stimulus comes first to the auricles, this continues as a wave on through the auriculoventricular bundle (see diagram) to the

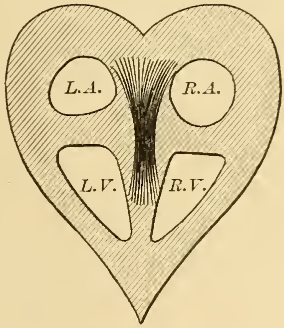


FIG. 14.—Diagram of heart. Auriculoventricular bundle.

muscles of the ventricles. Therefore in normal conditions the auricles beat first, each beat is followed at once by the beat of the ventricles, and the ventricular beat determines the rate of the pulse.

Pathological Conditions of Heart.—If for some reason the wave of contraction from the auricles to the ventricles is interfered with, the ventricles still beat by themselves, but at a very slow rate, about 30–40 per minute. This condition is called "heart block."

When the heart becomes overirritable, instead of the harmonious contraction of all the fibers of the auricles or of the ventricles little individual bundles of fibers act by themselves and the rhythm of contraction is lost. This is said to be a state of fibrillation; if in the auricles, auricular fibrillation, if in the ventricles, ventricular fibrillation. The latter is a serious condition probably always fatal; the former is in itself a very serious condition and at times tends to produce the latter.

Effects on Pulse.—Some of the pathological conditions which occur in the heart are briefly outlined below so that the action of digitalis and strophanthus may be more clearly understood.

Pathological Condition.	Kind of Pulse.
1. Loss of tone, contractility, or irritability.	Weak, regular rhythm.
2. Excessive irritability, "fibrillation."	Rapid, irregular rhythm.
3. Heart block.	Very slow, or sudden change from fast to slow.
4. Valvular lesions.	

Therapeutic Action.—*Primary.*—Digitalis and strophanthus often, but not always, improve the first condition by restoring the muscles to their normal condition. Their greatest use, however, is in auricular fibrillation. They act in this case by increasing the tone of the muscles and by creating a beneficial heart block. The first restores the rhythm, the latter slows the rate of the pulse. Slowing of the ventricular beat by these drugs is largely due to a stimulation of the vagus centre and to a certain degree of heart

Fig. 15.—Record of the heart beat and the pulse beat during the first five days of a case in the Presbyterian Hospital, New York, of chronic decompensation complicated with auricular fibrillation, mitral stenosis, and insufficiency. The first order was infusion of digitalis, ʒj, 4 i. d. At 5.30 p.m. on the first day strophanthin, gr. $\frac{1}{200}$, was given intravenously and at 11.30 p.m. the dose was repeated hypodermically. On the second day the standing order was changed to ♏x of digalen (a preparation of digitoxin) by hypodermic injection q. 4 h., and on the fifth day the dose was reduced to ♏v.

block. Auricular fibrillation is sometimes a chronic condition, but more or less continuous administration of one of these heart tonics may maintain fairly good health. As digitalis in overdoses may cause heart block, it is contra-indicated for general use in the third pathological condition. In valvular troubles these drugs are used to correct a failure of compensation of the heart by increasing the force of its contractions.

In cases where there is cardiac weakness the muscular contractions of the heart have not sufficient force to transmit all the beats to the pulse, and while the *heart* is beating very rapidly the *pulse beat* is slow or entirely absent. The effect of the heart tonics in such cases is to slow the heart beat and increase the pulse beat (see Fig. 15).

Secondary.—The secondary result of the action of these drugs on the heart is improvement in the general circulation, and as a result of that the blood gets more oxygen, all organs *including the heart itself* are better nourished, blood-pressure may be raised, lowered or remain unaltered, and any edematous condition removed if it is due to poor circulation. In cases of edema an increased diuresis necessarily follows the administration of digitalis and strophanthus to carry the extra fluids from the blood. There is likely to be nausea attending the administration of these drugs.

Administration.—*Digitalis.*—Digitalis may be given in the form of the **powdered leaves**, dose 1 grain (0.064 Gm.), the **tincture** (10 per cent.), dose 15 minims (1 Cc.), or the **infusion**, dose 2 fluidrams (8 Cc.). These doses in severe cases may be much increased. All the active principles of these drugs are glucosides. There has

been much confusion in the isolation and naming of these principles and still more in the clinical results of their use. The **glucosides** of digitalis which have had some use are **digitoxin, digitalin,** and **digitalein.** *Digitoxin,* dose $\frac{1}{250}$ grain (0.00025 Gm.), most completely represents the action of digitalis but is very irritant when given subcutaneously and is not sufficiently soluble in water for this purpose. A new proprietary form of digitalis which has proved of value is **digipuratum.** This is an extract of digitalis largely freed from its irritant principles and mixed with sugar of milk. It is supplied in tablet form (one tablet = one dose of digitalis) and in solution for injection into the tissues or the veins (15 minims (1 Cc.) = one dose of digitalis).

Strophanthus.—Strophanthus is given in the form of the **tincture,** dose by mouth 8 minims (0.5 Cc.). Its oral use is by no means safe as its absorption is very variable and a continued administration of even small doses has caused serious results without preliminary symptoms. The **glucoside** of strophanthus is **strophanthin.** Strophanthin-k, strophanthin-g, and g-strophanthin indicate merely the different species of the plant from which they are derived. Strophanthin-k is the glucoside commonly called simply strophanthin, its dose being $\frac{1}{200}$ grain (0.0003 Gm.). g-strophanthin, also called **ouabain** (pronounced wä-bā-ene), is commonly given intramuscularly or intravenously, the maximum single dose being about $\frac{1}{130}$ grain (0.0005 Gm.).

Strophanthin or ouabain should not be given intravenously in the above doses within two weeks after a full course of digitalis which is very persistent in

action. Therefore a nurse should record and report accurately the cessation of previous digitalis treatment.

Special Factors in Administration.—There are several factors which determine the method of giving these drugs. If they are given by mouth eighteen to twenty-four hours pass before they manifest any action at all. In emergency cases strophanthin or ouabain are given intravenously or intramuscularly. When the action has once started the doses are regulated in size and interval to suit the individual case. As digitalis is persistent in action, the intervals between doses are long and after the drug has been entirely stopped the effect will continue from one to three weeks. On account of this prolonged action and the fact that the crude drugs and their glucosides all act alike, it is important for a doctor on a new case to know if the patient has been using these remedies in any form and if so when the last dose was taken.

Toxicology.—In case of overdosing, if treatment is possible before absorption, give lavage with potassium permanganate. The toxic symptoms are a *marked* nausea, a very slow pulse, or any sudden change in the character of the pulse from fast to slow, regular to irregular, or *vice versa.* When any of these conditions appear, they should be reported, the drug stopped, and the patient kept quiet and warm until the arrival of a physician.

MUSCLE DEPRESSANTS.

Nitrites.—The nitrites, as a class of medicines, include **sodium nitrite** ($NaNO_2$), **amyl nitrite** ($C_5H_{11}NO_2$),

and three nitrates which break down to nitrites, **nitroglycerin** ($C_3H_5(NO_3)_3$), **erythrol tetranitrate,** and **potassium nitrate** (KNO_3).

Action.—Their action is due to the nitrite radical, NO_2, which is a muscle depressant, that is, it causes the muscle fibers to relax. Their effects are seen chiefly on the muscles of the arteries and of the bronchi, the result being a relaxation of the bronchial wall and a dilatation of the arteries. The obvious secondary

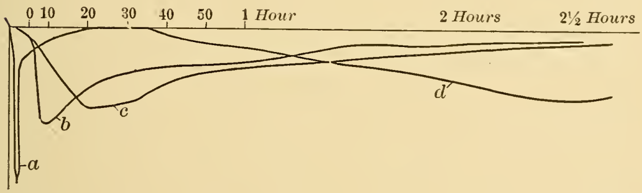


FIG. 16.—The extent of the fall of pressure is measured along the vertical line; the duration along the horizontal line. *a* = amyl nitrite, *b* = nitroglycerin, *c* = sodium nitrite, *d* = erythrol tetranitrate. (Bradbury.)

effects are a rapid, sometimes bounding, pulse and quickened respiration. In therapeutics the nitrites are used (1) to lower blood-pressure for the purpose of relieving an overworking heart in diseases characterized by a high blood-pressure, such as arteriosclerosis, chronic nephritis, and angina pectoris, and (2) to relax the bronchial tubes in asthma.

Comparison.—The individual members of this group of drugs differ in their speed and permanence of action more than in degree. Fig. 16 presents these variations graphically. It is readily seen that amyl nitrite is best adapted to emergency use in certain hysterical conditions and heart spasms; nitroglycerin and sodium

nitrite to moderate general action, and erythrol tetranitrate to chronic diseases and prophylaxis.

Description.—**Amyl nitrite** is highly volatile and is always given by inhalation. It is prepared in ampules of colored glass, each containing one dose, 3 minims (0.2 Cc.). When a dose is needed an ampule is broken in gauze or a handkerchief and the contents inhaled. **Sodium nitrite** is given in powder or tablet form, the dose being 1 grain (0.064 Gm.). **Nitroglycerin** is given by mouth or by hypodermic injection, the rate of action being about equal by the two methods. The dose is gr. $\frac{1}{100}$ (0.6 mg.). The chemical name of nitroglycerin is glyceryl trinitrate and the official preparation is a 1 per cent. spirit of glyceryl trinitrate, known also as spirit of glonoin. As it is a 1 per cent. spirit the dose is 1 minim (0.06 Cc.). Nitroglycerin is, however, usually given in the form of a tablet triturate. Because of the volatility of this drug these tablets will be of variable strength unless they are kept tightly stoppered. **Erythrol tetranitrate** is a preparation in tablet form, 1 grain (0.06 Gm.) being in each tablet. The last two drugs are highly explosive, and a nurse must never attempt to crush the tablets before administration or allow one to drop on the floor where it might be crushed under foot. **Potassium nitrate** is administered by burning the drug or a paper saturated with it and causing the fumes to be inhaled. The nitrate is converted to the nitrite in the process of burning. This drug is an ingredient of most popular asthma powders.

Toxicology.—Ordinary doses of nitrites may cause headache, dizziness, flushing of the face, and occa-

sionally collapse. Recovery is usually prompt but if treatment is needed give artificial respiration and stimulants.

MUSCLE STIMULANT.

Pituitary Extract.—Pituitary extract is usually in the form of a liquid preparation obtained from the posterior lobe of the pituitary gland. No active principle has as yet been isolated in pure form, pituitrin being simply a trade name for a purified extract. This drug is still in an experimental stage but it seems to be a direct muscle stimulant. Its action is manifested chiefly on the arteries and the uterus, causing those organs to contract. Indirectly the contraction of the arteries raises blood-pressure and increases the force of the heart beat. The arteries of the kidneys seem for some reason to be unaffected, and as this results in a much increased blood supply in those organs, diuresis may follow. Pituitary extract has been used with some success in hemorrhage from the lungs. If administered immediately after surgical operations it tends to increase the force of the heart; if given from six to eighteen hours later it assists in relieving flatulence. Its greatest use is in obstetrics. When given late in labor it increases the force of the contractions of the uterus and hastens delivery. It seems to lessen the danger of postpartum hemorrhage, and in some cases to obviate the need of catheterization following labor. It is given intravenously or subcutaneously in doses of 15 minims (1 Cc.).

CHAPTER XIII.

CIRCULATORY SYSTEM.

THE condition of the circulatory system can be altered by drugs through four different channels. Some drugs act directly on the heart; some change the calibre and tone of the bloodvessels; others affect the nerve centres controlling these organs; and some change the constituents of the blood. The parts of the circulatory system are so inter-related that a change in the condition of one affects the whole system.

DRUGS WHICH ACT ON THE HEART.

Heart Stimulants.

Drugs which act on the heart through the nervous system are true heart stimulants. They are **strychnine, caffeine, camphor,** and **atropine. Ammonium** is a cardiac stimulant which through reflex action increases the rate of the heart. (See Ammonium, page 170). Its effect is rapid but transitory. All these drugs increase the *rate* of the heart beat, not necessarily its *force.*

Heart Depressants.

Morphine, hydrated chloral, and the **bromides** in small doses are heart depressants and decrease its rate.

Aconite, which has already been mentioned as an anodyne, is a drug of very complex action on the nervous system which may be classed as a heart depressant. Its use is gradually being abandoned because of its extreme toxic action on the heart. It has some use in short acute fevers. (See Antipyretics, page 214.) The *tincture* is the preparation commonly used, the dose of which is 3 minims (0.2 Cc.). The characteristic symptom of aconite poisoning is tingling of the mouth and throat immediately after swallowing, next of the finger tips, and later of the whole body. First-aid treatment is lavage, absolute rest, and external heat. Later treatment will be to support the respiration.

Another heart depressant is **veratrum,** synonym hellebore, a drug the use of which is practically limited to the treatment of eclampsia. Its action is to slow and quiet the heart by stimulation of the vagus centre and to reduce blood-pressure. There are two different species of veratrum from which the alkaloids veratrine, cevadine, and protoveratrine are obtained. The crude drug is usually used in the form of the *fluidextract,* dose 1–3 minims (0.06–0.2 Cc.).

Heart Tonics.

Digitalis and **strophanthus** are true heart tonics because they increase its nutrition and the *force* of its beat. They slow the rate of the heart but leave it well nourished and strong.

Therapeutic Use of Heart Drugs.—Heart stimulants are indicated in crises as in shock or in acute diseases.

Heart depressants are needed most often in nervous disorders when the whole nervous system is in an irritable state. They are also used to lower blood-pressure. Heart tonics are indicated in the diseased conditions of the heart itself, resulting from overstrain or toxins from some infectious disease of the body.

DRUGS WHICH ACT ON THE ARTERIES.

Vasodilators.

Drugs which relax the walls of the arteries are called vasodilators; those which constrict them, vasoconstrictors. Both classes are used to affect blood-pressure and, through it, the heart. The **nitrites** (page 152) are vasodilators, and are indicated in diseases characterized by high blood-pressure as arteriosclerosis, chronic nephritis, angina pectoris, eclampsia, and other spasmodic conditions. They relieve an overworking heart, decreasing its force and increasing its rate.

Vasoconstrictors.

Vasoconstrictors are used locally to check hemorrhage, systemically to raise blood-pressure in shock and collapse and to increase the force of the heart. **Pituitary extract** (page 155) is a vasoconstrictor by its action on the muscles of the arteries. A more important drug of this class is **epinephrine** which acts on the nerve endings of the arteries.

Epinephrine.—Epinephrine is an alkaloid derived from the adrenal gland of animals, chiefly cattle and

sheep. Its chloride was first produced in commercial form by Parke, Davis & Company under the trade name of adrenalin chloride. Other drug firms and meat-packing houses have put similar preparations on the market under the names supracapsulin, adnephrin, suprarenin synthetic and others. (See N. N. R.)

Action.—Epinephrine stimulates the endings of all nerves which pass through the sympathetic system but in therapeutics its use is limited chiefly to stimulation of *vasoconstrictor* nerve endings (see Fig. 11, page 138). It also stimulates at the same time the *vasodilator* nerve endings with the result that after the constrictor action is passed the arteries, instead of resuming their normal size, become very much dilated. This limits the use of epinephrine as a hemostatic, a remedy to check hemorrhage. For the same reason when epinephrine is used over long periods in the nasal cavities for hay fever it is liable to produce a chronic inflammatory state. In the bronchi the dilator action only is apparent and is used in asthma.

Methods of Administration.—The greatest use of epinephrine is as a hemostatic. If taken by mouth it exerts only a local action on the stomach as it is destroyed by the gastric juices before absorption. If injected *subcutaneously* it acts around the area of injection and is only slightly absorbed. It is given in this way in combination with cocaine in minor surgery for its local vasoconstrictor action and in asthma alone for its bronchodilator action. When given *intramuscularly* the systemic action is more pronounced and by this method in postpartum

hemorrhage the uterine muscles are contracted, thus mechanically closing the open ends of the bloodvessels. By *intravenous* injection the greatest systemic effects are produced but they are very fleeting, often lasting not more than five minutes. This method is employed for emergency treatment to raise blood-pressure.

Therapeutic Uses.—The chief therapeutic uses of epinephrine are:

1. To check hemorrhages on abraded surfaces of the skin and mucous membranes.

2. To relieve asthma (subcutaneously).

5. To check postpartum hemorrhage (intramuscularly or by douche).

6. To raise blood-pressure in shock or collapse (intravenously).

Dosage.—For local application the solution of adrenalin chloride is used. It is supplied for this purpose in a 1 to 1000 solution, and can be applied full strength on the skin but should be diluted to 1 to 5000 or 1 to 8000 for use on mucous membranes. 15 minims (1 Cc.) of the 1 to 1000 solution is the dose for hypodermic or intramuscular injection. The same dose is given by vein and has to be given very slowly to avoid heart failure by a sudden rise of blood-pressure or by direct action on the heart.

Tyramine; Ergotoxine.—Tyramine and ergotoxine are two alkaloids derived from ergot (page 229) which are very similar to epinephrine in composition and action (see Fig. 11, page 138). These alkaloids are used as vasoconstrictors to raise blood-pressure in shock or collapse. Their action is not so prompt as epinephrine but three or four times more

prolonged. They act almost equally well by mouth, by subcutaneous or by intravenous injection. The dose of ergotoxine is grain $\frac{1}{50}$ (0.0012 Gm.); of tyramine grain $\frac{1}{2}$ (0.03 Gm.). As ergotoxin in *large* doses *paralyzes* the constrictor nerve endings, repeated doses are unsafe.

DRUGS WHICH AFFECT THE BLOOD.

The common pathological conditions of the blood itself are (1) decreased alkalinity; (2) decreased coagulability; (3) excessive coagulability; (4) deficiency in hemoglobin; and (5) a low percentage of red or white corpuscles.

Antacids.

An excessive acidity of the blood is a rare condition. It is supposed to be the cause of coma in diabetes and is present in delayed chloroform poisoning. In such cases an attempt is made to neutralize the blood by giving large quantities of **sodium carbonate** or **bicarbonate.** These salts may be administered as a prophylactic or as a medicine. They are given by mouth in very large doses, by rectum in still larger doses by the drop method, and in solution intravenously. Results are not always good but a sufficient number of cases have been benefited to justify trial of this treatment.

To Increase Coagulability.

Attempts to change the degree of the coagulability of the blood by administration of drugs have met

with varying success. In severe hemorrhages and in hemophilia, a disease in which there is excessive bleeding on slight provocation, and in diseases characterized by capillary hemorrhages, the coagulability of the blood is much decreased. Most of the remedies used to restore this property are empirical but they are harmless and worth trial. In the diseases mentioned above calcium is the constituent of the blood which is lacking, and it is administered in the form of **calcium chloride** or **lactate.** It is doubtful if sufficient calcium is absorbed when these salts are given by mouth to produce beneficial results. Their administration by hypodermic injection is very painful. The best results are by intravenous injection of a weak solution. **Defibrinated blood** of animals or **ascitic fluid** taken from some dropsical patient are tried in cases of severe hemorrhage, also normal blood serum from some animal or in the form of diphtheria antitoxin.

To Decrease Coagulability.

When the blood coagulates very easily clots tend to form in the vascular system and cause thrombosis or embolism. No cure for this condition has as yet been found. **Citric acid** and some of the soluble **citrates** have been tried but there is no proof that the amounts that can be given in therapeutics have any appreciable effect.

Hematinics.

Hematinics are medicines given to increase the hemoglobin content of the blood. A common

disease in which hemoglobin of the blood is deficient is anemia. Anemia is the predisposing cause of many disorders, such as chorea, heart irregularities, menstrual troubles, and many nervous conditions. The most rational method of treating this disease of the blood is by living day and night in the fresh air, taking exhilarating exercise, and a nourishing diet. This is not always possible and often needs to be supplemented by drugs.

Iron.—The one great hematinic of medicine is iron which is an essential constituent of hemoglobin. The use of iron as a blood medicine dates back to very early times. It was based on the belief that as iron implements were strong a medicine containing iron would give strength. It was administered in the form of water in which swords had lain for a long time and rusted.

The Normal Supply.—There are from 40 to 50 grains of iron in a normal human body, about enough to make a two-inch nail. The daily demand to keep up this amount is very small, from $\frac{1}{10}$ to $\frac{1}{4}$ of a grain and it is easily supplied in an ordinary diet. In some cases of anemia a special diet rich in iron will effect a cure. If, however, the supply is seriously depleted as after a hemorrhage or a wasting fever, diet alone is often not sufficient to make up the loss.

Foods which are richest in iron are beef, spinach, the yolk of an egg, and lentils. Legumes, wheat, potatoes, and oatmeal are next in their iron content. Milk and its derivatives are very poor in iron, although two and a half pints of milk contain $\frac{1}{6}$ of a grain.

Action.—The action of iron as a hematinic is simply to supply a deficiency for the manufacture of hemoglobin. There may be some stimulation of the appetite and of the red marrow where red corpuscles are made but these actions are comparatively unimportant.

Iron Compounds.—There is still much disagreement in regard to the comparative value of the so-called organic and inorganic iron. The distinction here is not the same as between the two branches of chemistry but depends on the reaction to chemical tests for free iron. If some chloride of iron be put into solution and tested with a chemical reagent for iron the presence of the metal is readily seen. Ferric citrate which in chemical terminology is an *organic* salt gives the same result in this test and is considered an *inorganic* preparation of iron. If iron compounds such as hemoglobin and ferratin be subjected to this test it is necessary to break down the compounds with an acid or even by incineration before the free iron will show. Such compounds are said to be organic. (See Experiment IX, page 262.) It is now a fairly well-established fact that all forms of iron, organic or inorganic, are absorbed and act as hematinics. They differ, however, in side actions. Many inorganic preparations of iron irritate the stomach, derange digestion, cause frontal headache, destroy the enamel of the teeth if allowed to come into contact with it, and are so astringent as to cause constipation. This is not true of organic iron preparations. It is probable that much smaller doses of inorganic iron than are commonly given would be just as efficient and give no side actions.

Dosage.—There are thirty-six official preparations of iron, and many more which are proprietary (see N. N. R.). The official compounds most used are the following:

Reduced iron (made from the oxide by reduction by hydrogen),	gr. j (0.064 Gm.)
Pills of ferrous carbonate (Blaud's pills),	2 pills
Tincture of ferric chloride,	♏viij (0.5 Cc.)
Pills of ferrous iodide,	2 pills
Syrup of ferrous iodide (much used for children),	♏xv (1 Cc.)
Ferric and ammonium citrate,	gr. iv (0.25 Gm.)
Ferric and ammonium tartrate (considered the most absorbable inorganic iron),	gr. iv (0.25 Gm.)
Solution of ferric and ammonium acetate (Basham's mixture),	ʒj–iv (4–16 Cc.)

These are all forms of inorganic iron and must be so administered as not to corrode the teeth. Some of the popular organic iron preparations are ferratin, hemaboloids, hemogallol, and ovoferrin. Iron may be given intramuscularly in the form of the glycerophosphate, in a solution of iron and ammonium acetate and other forms. When taken by mouth it should preferably follow meals. Hemoglobin itself and extract of red marrow are obtained from animals and are sometimes used as medicines but they do not seem superior to more palatable forms of iron.

Arsenic.—Another drug which may be classed as a hematinic is **arsenic**. It produces especially good results when given in combination with iron.

Arsenic trioxide, As_2O_3, is the form in which arsenic is given as a medicine. It is a white powder which in solution in water forms arsenous acid.

$$\underset{\text{Arsenic trioxide.}}{As_2O_3} + 3H_2O \rightarrow \underset{\text{Arsenous acid.}}{2H_3AsO_3}$$

These properties have led to the use of numerous names for this drug. The terms white arsenic, arsenous oxide, arsenous acid, arsenous anhydride, and arsenic all mean arsenic trioxide when applied to the medicine. For convenience hereafter the last will be used. Arsenic, in the form of complex salts, has in the past been a common poison because of its use in dyes, wall papers, Paris green, rat poisons, and for criminal purposes. The percentage of it in dyes and in wall papers is now restricted by law.

Therapeutic Uses.—Arsenic has four very distinct uses in medicine.

1. Locally as a caustic.
2. Internally in dry skin diseases.
3. Internally in diseases of the blood.
4. Internally as a specific against higher organisms. (See Antisyphilitics.)

Local Action.—Locally arsenic is a caustic by creating such an intense inflammation that the tissues die. It is an ingredient in most quack cancer cures and is used to some extent in legitimate medicine for treatment of superficial malignant diseases and in dentistry to kill nerves of the teeth. The use of arsenic on the skin is gradually being discontinued as it is very painful and may be followed by systemic effects due to absorption.

Systemic Action.—*On Skin.*—When arsenic is given internally it causes the walls of the capillaries to dilate and thus become very much more permeable. In *small* doses this results in an increased nutrition of the skin. This in part explains its use in cosmetics, in

dry, scaly, skin diseases, and by veterinarians to give gloss to a horse's coat. It may also account for the improvement in digestion which often follows a course of arsenic. After *large* doses this action results in a general edema shown by puffiness about the eyes and an inflammatory condition of the alimentary canal. In cases of poisoning the extreme inflammation causes sloughing of the gastro-intestinal mucous membrane with resulting white or "rice-water" stools.

On Blood.—Diseases of the blood are benefited by the increased nutrition of the blood-making tissue, the red marrow of the bones. It seems to cause some increase in the number of red corpuscles, but little in the amount of hemoglobin. Arsenic does, however, very much benefit some diseases in which red corpuscles are being destroyed, as in pernicious anemia. Its greatest use is in diseases in which the leukocytes are abnormally increased, as in leukemia.

Dosage.—Arsenic is most frequently given in the form of the **Solution of Potassium Arsenite** (Liquor Potassii Arsenitis), popularly called Fowler's Solution. This preparation does not keep well. Its dose is 3 minims (0.2 Cc.). The **Solution of Arsenous Acid**, same dose, and the **Solution of Arsenic and Mercuric Iodide** (Donovan's Solution), dose $1\frac{1}{4}$ minims (0.1 Cc.), are other preparations of arsenic. Atoxyl and salvarsan are complex arsenic compounds used chiefly for specific action in syphilis (see page 221). **Sodium cacodylate** is a synthetic compound which breaks down slowly in the body and liberates arsenous acid. Because of its slow decomposition it is claimed to be less toxic

and freer of side actions than ordinary forms of arsenic. As it tends to decompose in the juices of the stomach it is often given by hypodermic injection. Its dose is ½ grain (0.03 Gm.).

Some physicians believe that arsenic is at all times best given by hypodermic injection. In this way smaller doses are required, irritation of the alimentary canal is avoided, and it is claimed that toxic symptoms rarely appear. The injections frequently cause considerable irritation. A course of arsenic treatment is usually commenced with minimum doses and gradually increased until symptoms of overdosing appear. A great degree of tolerance is attained. Preparations of arsenic by mouth are best given directly after meals.

Toxicology.—Mild overdosing may be detected by puffiness about the eyes, coryza, and slight disorders of the alimentary canal. If these appear the drug should be stopped but no further treatment is necessary. The symptoms of acute poisoning by arsenic are those of acute inflammation of the alimentary canal, vomiting, cramps, and diarrhea followed by low blood-pressure and collapse from excessive loss of fluids. The treatment in such cases is administration of demulcents, preferably milk or white of egg, to relieve the local symptoms and of the chemical antidote, ferric hydroxide, U. S. P. This antidote is never at hand but must be secured as soon as possible from a pharmacy and given as directed. Some investigators have found this antidote useless but it has not as yet been discarded. Radical measures to check the diarrhea should be

avoided as the poison is eliminated in this way. Further treatment is for collapse. Chronic poisoning by arsenic may take many forms, giving the varied symptoms of loss of appetite, emaciation, fever, sneezing, coughing, jaundice, extreme neuritis, and pigmentation of the skin.

CHAPTER XIV.

RESPIRATORY SYSTEM.

Disorders of the respiratory system are treated by drugs which act on the respiratory centre and by those which exert a local action on the lining membrane of the respiratory passages. The local effect may be obtained by inhalation of medicines or by their excretion through the lungs. Respiration and heart action are so closely related that a change in one often produces a like change in the other.

The classes of drugs which affect this system by *central action* are the **respiratory stimulants** and **sedatives.** Those which act *locally* are the **respiratory antispasmodics, antiseptics, demulcents,** and **expectorants.**

Respiratory Stimulants.

Strychnine, atropine, caffeine and **camphor** are the important respiratory stimulants. **Artificial respiration** is often of more value than any drug. It rests the respiratory centre and keeps up the mechanical movements of respiration until the centre is able again to resume control. **Ammonium,** to be studied next, is a respiratory stimulant chiefly by reflex action.

Ammonium.—The action of any ammonium compound on the respiratory system is due to the ammo-

nium ion, NH_4. Therefore to secure this effect a compound must be used from which the ion is easily liberated. Such compounds are ammonium hydroxide, NH_4OH, and ammonium carbonate, $(NH_4)_2CO_3$. The first is used in medicine in the form of the aromatic spirit, the latter in its original form always in solution.

Action.—Ammonium hydroxide is a local irritant. When applied to the skin in liniments it is a counter-irritant, due to the liberation of the irritating ammonia gas, NH_3. On mucous membranes both the hydroxide and carbonate have two actions: **a stimulation at the point of application** causing an increase of mucous secretions and a **very prompt reflex action** on the respiratory centre. Both occur whether the drug be inhaled or taken by mouth and excreted by the lungs. Ammonium in the blood stream is used in the manufacture of urea, $(NH_2)_2CO$, but if any reaches the respiratory centre it directly stimulates it.

Therapeutic Uses.—Ammonium hydroxide is used in therapeutics as a counter-irritant; the hydroxide and carbonate (1) as quick respiratory stimulants, and (2) to increase secretions of the respiratory tract (expectorants).

Dosage.—The familiar remedy for fainting, **Aromatic Spirit of Ammonia**, contains ammonia water 9 per cent., and ammonium carbonate 3.5 per cent., besides a large percentage of alcohol (see page 110), all three ingredients being quick reflex stimulants. This is given by inhalation or by mouth in doses of 15–60 minims (1–4 Cc.). Ammonium carbonate is also given by both methods, the dose by mouth being 4 grains

(0.25 Gm.). Ammonium hydroxide or carbonate is the active constituent of smelling salts. As the value of these two drugs depends on their local irritant action they should not be given by mouth too dilute. The aromatic spirit is best diluted about four times, and one dose of the carbonate dissolved in about half an ounce (15 Cc.) of water. There are two salts of ammonium used in medicine from which the radical is not easily liberated, ammonium chloride and acetate, and they act in an entirely different manner from the ones just described. Ammonium chloride exerts salt action on the respiratory passages changing the amount and character of the secretions. (See Expectorants, page 176.) Ammonium acetate by a central action stimulates sweating and will be considered as a diaphoretic, page 201.

Respiratory Sedatives.

Respiratory sedatives are the central depressants, **morphine** and **codeine.** They are indicated in coughs but should be used only as a last resort because of the danger of habit formation. The markets are flooded with patent cough mixtures, many of which contain morphine, codeine, heroin, or chloral in large enough quantities to produce the drug habit and thus increase the sale of the medicine. Many others are so innocuous that administration of plain sugar syrup would do just as much good and be much cheaper. The **nitrites** and **atropine,** used as antispasmodics in asthma, may be included in this class.

Respiratory Antispasmodics.

There are two drugs of some importance which act as antispasmodics on the respiratory tract. They are **stramonium** and **wild cherry.** The inhalation of steam alone has a similar soothing effect. Stramonium owes its activity to hyoscyamine (see page 99). Its chief use is in asthma and it is an ingredient of most asthma powders. It is always administered by burning the leaves in a saucer and causing the fumes to be inhaled or in a pipe or cigarette for smoking. Sometimes it is given in combination with potassium nitrate, the leaves being previously soaked in a solution of the nitrate and dried. These treatments by inhalation may be continued until the spasmodic condition is relieved and repeated whenever demanded. Wild cherry has for its active principle hydrocyanic acid which depresses the respiratory centre and the sensory nerve endings. It is present, however, in such small quantities that the usefulness of wild cherry in cough mixtures is probably limited to that of a flavor.

Respiratory Antiseptics.

The common respiratory antiseptics are **guaiacol, creosote, benzoin,** and the **oil of eucalyptus.** They are administered by inhalation and by mouth.

Creosote and Guaiacol.—**Creosote** is a volatile oil derived by the distillation of wood tar, preferably from beechwood. It contains from 60–90 per cent. of guaiacol, a clear, colorless liquid having a similar

odor and taste. **Guaiacol** is more constant in composition and less irritating. In *ordinary* doses both these drugs tend to derange digestion; in *large* doses they are very depressing and may cause sudden collapse even when absorbed from the skin. In some way, not yet explained, they allay inflammation of the respiratory tract even if this inflammation is not septic. For inhalation they may be dropped on a mask or added to boiling water and inhaled with the steam. They are valuable in diseases of the respiratory tract which are characterized by a foul odor. In phthisis and bronchitis they may be used internally in doses of 3 minims (0.2 Cc.). Their taste must be disguised in some way either by giving them on sugar, in milk, or in an aromatic tincture like the compound tincture of gentian. For internal administration the carbonates of creosote and guaiacol may be used, **guaiacol carbonate** being tasteless, odorless, and especially well borne by the stomach. It is given in a powder, a capsule, and an emulsion.

Benzoin.—Benzoin is a solid balsam. All balsams contain three antiseptic principles, a volatile oil and two acids, benzoic and cinnamic. The liquid balsam of Tolu is similar to benzoin in its effect but it is so weak that its value in syrups is chiefly as a vehicle. The *Compound Tincture of Benzoin,* the form usually used, is administered by inhalation from a croup kettle or a pitcher of boiling water to which one teaspoonful has been added.

Oil of Eucalyptus.—The oil of eucalyptus is one of the strongest of the antiseptic oils. Eucalyptus trees

are native to Australia but are being cultivated extensively in California. Their roots grow to such a depth that they serve as drainage to the land; the leaves are so antiseptic that they purify the soil in malarial districts. The oil and **eucalyptol**, a derivative of it, are almost specific in diseases of the chest. They are administered by inhalation with steam or by an atomizer. Camphor and menthol are frequently combined with them.

Respiratory Demulcents.—Respiratory demulcents protect irritated surfaces from contact with the air and thus check coughing. Such substances must be taken by mouth and reach only the upper air passages. They may spread to some extent over areas which they do not touch when swallowed. These drugs are medicinally inert and can be taken freely. The simplest demulcent is **simple syrup**, a dense solution of sugar. Another is **syrup of acacia** (gum arabic), a gum much used in pharmacy in making emulsions and pills. The **mucilage of sassafras** and the **mucilage** and **troches** of **slippery elm** are simple remedies made from common trees of the United States. The latter is the inner bark of a species of elm called Red Elm.

Another popular demulcent is **licorice**, the botanical name for which is glycyrrhiza. Glycyrrhiza is a native shrub of Europe, and it is estimated that about 100,000,000 pounds of its root or a pure extract are exported to the United States annually. The familiar black licorice sticks are the pure extract. More than as a respiratory demulcent this drug is used as a pleasing vehicle for other medicines. The Compound Licorice

Powder, U. S. P., a cathartic mixture, owes its activity to sulphur and senna.

Expectorants.—Expectorants are medicines which increase and fluidify bronchial mucus, thus facilitating its removal. They are usually given in the early stages of pharyngitis, laryngitis, bronchitis, and pneumonia to relieve a dry congestion. Some writers classify them as stimulating or depressing, referring to their effect on the general condition of the patient. There is no uniformity in their method of action.

The common expectorants are **ammonium chloride** and **carbonate**, the **iodides**, **terpin hydrate**, **apomorphine**. **ipecac**, **tartar emetic**, and **squill**.

Nauseating Expectorants.—The last four drugs named above are called nauseating expectorants because they act by creating a slight nausea and in large doses they cause vomiting. **Apomorphine** is an alkaloid derived from morphine by dehydration. It is given as an expectorant in doses of $\frac{1}{60}$ to $\frac{1}{30}$ of a grain (0.001–0.002 Gm.). **Ipecac** (ipecacuanha) is a root drug from Brazil. The drug is expensive because it causes a pustular rash on the hands of the native collectors and they will not gather it if they can find anything else to do. Ipecac is almost never given now as an emetic and is being used less and less as an expectorant. The common preparations are the *syrup*, dose 4 minims (0.25 Cc.) and the *wine*, dose 10 minims (0.6 Cc.). **Tartar emetic**, a popular name for antimony and potassium tartrate, has fallen largely into disuse because it tends to cause general depression. It enters into some expectorant mixtures which, on account of the

depressing effect of this ingredient, should be used with caution. Two of these mixtures are the Compound Licorice Mixture (Brown Mixture) which contains paregoric as well as tartar emetic (in the form of wine of antimony) and the Compound Syrup of Squill (Coxe's hive syrup). Patients who are taking either of these mixtures should be watched for symptoms of depression. **Squill** (scilla) is given in the form of the *syrup* and the *compound syrup* mentioned above. The syrup is made from the vinegar of squill, a preparation in which the drug is extracted with acetic acid. The dose is 30 minims (2 Cc.).

Stokes' expectorant, a National Formulary preparation, contains squill, senega, ammonium carbonate and paregoric.

Ammonium Compounds.—Of the two ammonium compounds, ammonium chloride and carbonate, the chloride is the more important as an expectorant. In congestion of the throat it acts as an astringent and increases the saliva by salt action. In such cases it is taken in the form of tablets or troches which are dissolved in the mouth. For medication of the larynx and bronchial tubes it is inhaled. There is a special apparatus in which the salt is made by mixing the two gases, hydrochloric acid and ammonia. The same results are obtained by placing near together two open dishes containing solutions of these gases. (This can be demonstrated by holding together the mouths of bottles which contain solutions of the gases.) Ammonium chloride is a common ingredient in cough mixtures. The dose is 5–15 grains (0.3–1 Gm.).

Iodides.—The use of iodides as expectorants is largely empirical. Sodium and potassium iodide are given in average doses of 10 grains (0.6 Gm.). They should never be given in tubercular cases, for there is strong evidence that they interfere with the formation of new tissue. They relieve chronic bronchitis and emphysema in asthmatic patients, probably by their salt action. (For further description of the iodides, see page 211.)

Terpin Hydrate.—Terpin hydrate is a derivative of the oil of turpentine which has now largely displaced the oil for internal use. It is given as a powder or in capsules in doses of 2 grains (0.1 Gm.).

CHAPTER XV.

DIGESTIVE SYSTEM.

Most drugs which affect the digestive system act directly on the walls of the alimentary canal. A few act through the nervous system. There is none in use which has any known effect on the pancreas and only one or two which act on the liver.

The common affections resulting directly from disorders of the digestive system are gastric and intestinal indigestion, emesis, loss of appetite, infections, excessive flatulence, constipation, diarrhea, jaundice, diabetes, headaches, and auto-intoxication. In the prevention and treatment of such disorders more and more emphasis is being put on diet and hygienic living. Overeating, eating in haste, eating too rich foods, eating during extreme nervous fatigue or excitement, irregular meals, lack of physical exercise, eye-strain, mental depression, are all common causes of digestive disorders.

The drugs which act on this system are acids and alkalies (see Chapter VIII) and the following classes:

Class of drugs used for effect in mouth . .	sialagogues.
Classes of drugs used for effect in stomach	emetics. antiemetics. digestants. absorbents. stomachics.
Classes of drugs used for effect in intestines	antiseptics. carminatives. cathartics. antidiarrheics. anthelmintics.

EFFECT IN THE MOUTH.

Sialagogues.

Sialagogues are medicines which increase the flow of saliva. They are indicated in fevers to relieve thirst and usually consist of **fruit acids** given in the form of orangeade, lemonade or grape-juice. Their effect is largely due to salt action and direct stimulation of the secreting cells.

EFFECT IN THE STOMACH.

Emetics.

Emetics are medicines given to produce vomiting (emesis). **Warm water**, with or without salt (2 to 4 t. to a glass of water), is the best simple emetic given by mouth, and **apomorphine**, dose gr. $\frac{1}{10}$ (0.006 Gm.), the only available one for hypodermic injection. Warm water or saline given by mouth before apomorphine aids its action. A teaspoonful of **mustard** in warm water is an effective emetic *if the mustard is fresh and the water not too hot*, but it should not be used if the stomach is in an irritated condition. The latter is true of **powdered ipecac**, which may be given in doses of 15 grains (1 Gm.) in warm water. **Copper** and **zinc sulphate** are dangerous emetics if there is any abrasion on the stomach wall as they may be absorbed and cause general depression. When used they are usually administered in small doses at frequent intervals until 7 grains (0.5 Gm.) of copper sulphate and 30 grains (2 Gm.) of zinc sulphate are given or emesis produced.

Antiemetics.

Antiemetics, as the name implies, are given to check emesis. As the cause of emesis is usually a local irritation of the lining of the stomach or a stimulation of the vomiting centre, the treatment is to remove the local cause by emetics and cathartics, to soothe any subsequent irritation, and to depress the vomiting centre by **morphine.** The first method may be sufficient in some cases; in others all have to be tried. If emesis is due to excessive acidity, **lime-water** or **sodium bicarbonate** are indicated for neutralization; if due to excessive irritability, the treatment may be **counter-irritants,** an **ice-bag** over the gastric region, **bismuth** to coat over the surface, or **cocaine** to paralyze the sensory nerve endings. It is known by experience that **champagne** and **carborated drinks** are effective in postoperative vomiting, probably because of the slight stimulating action of carbon dioxide gas. **Cerium oxalate** is a remedy which is usually tried in the vomiting of pregnancy, and is often given in combination with sodium bicarbonate. Its action is purely mechanical like that of bismuth. Probably much larger doses than are usually given are required to obtain good results. The usual dose is about 5 grains (0.3 Gm.).

Digestants.

Digestants are animal or vegetable ferments given to supplement the action of the natural digestive ferments. The importance of this class of medicines has much decreased in late years for it has been

proved that only in rare cases of atrophy of the mucous membrane are the natural ferments decreased in quantity.

Pepsin.—Pepsin, a protein digesting ferment derived from the stomach of swine, acts only in a mildly acid medium and is often given in combination with hydrochloric acid. Papain is a vegetable ferment resembling pepsin. Papayan tablets, a proprietary remedy for indigestion, were advertised to contain papain, but they consist chiefly of sodium bicarbonate and charcoal.

Pancreatin.—Pancreatin, a mixture of pancreatic ferments also derived from swine, acts only in an alkaline medium and, as it is destroyed in the stomach, it has no effect on intestinal digestion. It is sometimes given with sodium bicarbonate for the same disorders as are treated by pepsin and hydrochloric acid. The chief therapeutic use of pancreatin is to predigest or peptonize milk. Pepsin cannot be used for this purpose, as it always contains mixed with it some rennin which coagulates the milk. It has been proved beyond a doubt that pepsin and pancreatin, when mixed together in solution, destroy each other. There are, however, well-advertised and widely used proprietary "digestive tablets" which contain these two ferments alone or in combination with diastase and one or more acids. These mixtures are typical "shotgun" prescriptions the use of which is wholly irrational and unscientific.

Diastases.—Diastase is a starch-digesting ferment of barley malt. **Taka-diastase**, similar to diastase in action, is derived from a mold of the rice-plant in Japan. The diastases are on the market in numerous

forms, as maltine, maltzyme, panase, diazyme essence, and extracts of malt. The claims of the manufacturers as to the digestive powers of these remedies should be taken with reservation. Preparations of taka-diastase lose their digestive powers with age.

Absorbent.

Charcoal.—Animal charcoal is a simple drug which has the property of absorbing gases. Such a remedy is known as an absorbent. As charcoal loses its absorptive power when wet, its administration is irrational except in capsules. Charcoal tablets should not be chewed or allowed to dissolve in the mouth. Even if this drug reaches the stomach dry it soon is moistened in the juices and rendered inert. Charcoal is sometimes given in large amounts in cases of acute poisoning by arsenic, alkaloids and other drugs in the hope that the poison will be absorbed from its solution and made harmless.

Stomachics.

Method of Action (see Fig. 11, page 138).—Stomachics are medicines which improve the appetite and digestion chiefly by stimulating the taste organs. It is a well-known fact that the taste, the smell or even the thought of food of which a person is particularly fond will cause an increase of the amount of saliva in the mouth. The expression is that "it makes the mouth water." At the same time reflex stimuli from the mouth start the flow of gastric juices. The reflex stimuli

depend largely on the taste buds located on the back of the tongue. If for some reason these organs are not functioning properly, food is not relished and if taken is not well digested. In such cases stomachics are indicated. This class of drugs probably exerts also some direct stimulation on the gastric secreting cells. Some are slightly antiseptic and if taken over long periods tend to inhibit ferment action and thus derange digestion. The bitter taste of a stomachic is the property upon which its action depends; hence if this is disguised to make the potion more palatable its value is lost. They should be taken about half an hour before meals.

Drugs.—The most important drug of this class is **gentian,** usually given in the form of a compound tincture of gentian. This preparation contains another stomachic, **bitter orange**, and a carminative, **cardamom.** Gentian enters into many tonics for the appetite. It is a root drug which comes chiefly from Europe. All bitters are very old medicines and this one is said to have been named from Gentiana, a king living in the second century before Christ, who first discovered its medicinal properties. Other stomachics are **sweet flag** (calamus), **calumba** (a root used as a panacea in East Africa), **dandelion** (taraxacum), and **quassia,** the wood of a tree native in Jamaica. These drugs are used in the form of *tinctures,* dose 1 dram (4 Cc.) and very frequently in home-made *infusions,* dose 1 to 2 fluidounces (30 to 60 Cc.). **Quinine, cinchona,** and **nux vomica,** because of bitter properties, are of some value as stomachics.

DRUGS WHICH ACT ON THE INTESTINES.

Antiseptics.

The common intestinal antiseptics are **guaiacol** and **creosote carbonates** (see page 174), **calomel** and **salol.** It is a question if any antiseptic is of much value in intestinal infections, but salol is probably the best. **Salol** (phenyl salicylate) breaks down in the intestines and liberates the two antiseptics from which it is made, phenol and salicylic acid (see Fig. 9, page 128). These decomposition products are absorbed and excreted in the urine, coloring it dark and acting to some extent as a urinary antiseptic. Salol is also used for the same purpose as phenacetine and often in combination with it. The dose is 3–8 grains (0.2–0.5 Gm.) preferably administered in capsules. As salol contains 40 per cent. of phenol, which is a powerful depressant, this drug must be used with some care.

Carminatives.

Action.—Carminatives are medicines given to assist in the expulsion of gas from the alimentary canal. Their action is twofold: they are antiseptic to the organisms which cause the gas and by a slight stimulation cause its expulsion without affecting the solid content of the stomach or bowel. Most carminatives owe their activity to a volatile oil.

Source of Gas.—One often wonders at the excessive quantities of gas sometimes present in the alimentary canal. Babies and neurotic patients swallow con-

siderable amounts with food. It is probable that the natural interchange of gases in the tissues is disordered in neurotics and abnormal amounts are excreted into the alimentary canal. Another source, and a frequent one, is the elimination of excessive amounts of hydrogen gas from the fermentation of carbohydrates, the digestion of which has been delayed. Hydrogen is very slowly absorbed, hence accumulates and causes flatulent colic. As prophylactic measures there should be thorough mastication of food, no fluid just at the beginning of the meal, a restriction of carbohydrates and an elimination of sugar in the diet.

Drugs.—The drugs which are commonly used as carminatives are the **oil of peppermint, cardamom, asafetida, oil of turpentine, myrrh, camphor,** and **capsicum. Oil of peppermint**, one of the few drugs produced in large amounts in this country, is usually administered in the form of the *spirit* or *essence* of peppermint in hot water or in the form of lozenges. The dose of the spirit is 30 minims (2 Cc.). **Cardamom**, the fruit of a reed-like plant in India, is official as a *tincture* and *compound tincture*, the dose of each being 1 dram (4 Cc.). **Asafetida** (see page 143) and **oil of turpentine** are used as carminatives mostly by enema, $\frac{1}{2}$ ounce (15 Cc.) of the latter being given in 6 ounces (180 Cc.) of oil or 1 pint ($\frac{1}{2}$L.) of soapsuds. **Myrrh**, a gum resin, is seldom used alone but in combination with cathartics. It is frequently added to gargles and mouth washes for an astringent action. **Capsicum**, a common name for which is cayenne pepper, is used in the form of the *tincture*, dose $7\frac{1}{2}$ minims (0.5 Cc.).

Cathartics.

Cathartics are medicines given to cause an evacuation of the bowels. Diet and exercise are most important factors in regulating catharsis. One or more glasses of cold water on rising, followed by a few abdominal or general exercises, for most people will ensure a regular evacuation. As a common cause of constipation is lack of fluids from two to four pints of water should be taken daily as a prophylactic. Laxative foods are green vegetables, coarse breads, fruits, especially apples, pears, and oranges, dried fruits, such as figs, prunes and dates, honey, molasses and oatmeal.

Action.—Most cathartic drugs owe their activity to some irritant active principle. They are usually given by mouth but they act only on the intestines because their active principles are not liberated until after they leave the stomach. The important factors to be considered in regard to cathartics are their *degree of action* and the *portion of the intestines affected.* As a rule the degree of action depends upon the size of the dose, although some are too weak ever to exert more than a mild action. Cathartics are frequently classified on the basis of the degree of action as **laxatives** or aperients, those having a mild action, **purgatives**, those causing full and free catharsis and **drastics**, those very severe in action. They will be considered first according to the part of the intestine upon which they act and then classified by the degree of action.

On Duodenum.—A few cathartics act chiefly on the duodenum—calomel and other mercurials and podo-

phyllum. As a result of the action of these drugs the contents of the duodenum is moved on and the increased bulk in passage through the intestines continues the peristalsis. To complete the evacuation these cathartics at times have to be supplemented by others which act on a lower part of the bowel. An evacuation of the duodenum opens a free passage for bile from the liver and the cathartics of this group are called cholagogues because of this secondary result. They do not, as was once believed, act directly on the liver. As biliousness, bilious headaches, and jaundice are often caused by absorption of bile and toxins which have accumulated in the duodenum these cathartics are indicated in the treatment of such disorders. **Calomel** (hydrargyri chloridum mite—mild mercurous chloride) is commonly administered in doses of $\frac{1}{10}$ to $\frac{1}{3}$ of a grain (0.006–0.02 Gm.) at intervals of twenty to thirty minutes until 1–3 grains (0.064–0.2 Gm.) are given. If a free evacuation is not secured within twelve hours a cathartic, preferably a saline, is given to secure the desired result and to prevent the absorption of mercury. **Mercury** (hydrargyrum) itself is given in finely divided particles in the form of blue mass or pill and with chalk in the so-called Gray Powder. The dose of each is 4 grains (0.25 Gm.) which is equivalent to about $1\frac{1}{2}$ grains (0.1 Gm.) of mercury. **Podophyllum**, an American root drug, is sometimes spoken of as "vegetable calomel" because it has an action similar to that of calomel. The active principle of podophyllum is a resin called **podophyllin** and this is the form used as a medicine. The dose is from $\frac{1}{20}$ to $\frac{1}{2}$ of a grain (0.003–0.03 Gm.) according to the degree of action desired.

On Liver.—Certain drugs are reputed to act directly on the liver and cause an increase in the excretion of bile. These drugs are sodium glycocholate, sodium taurocholate, ox-gall, and several proprietary mixtures of bile salts. Recent experiments have proved them of doubtful value.

On Small Intestines.—The cathartics which act on the small intestines are the **oils**, olive, croton and castor, and a group which, because their active principles are resins, are termed **resinous cathartics.**

Oils.—Of the first class, **olive oil** (oleum olivæ) is chiefly a lubricant and may be given in doses of 1 to 2 tablespoonfuls one-half hour before meals for a very mild action. **Croton oil** (oleum tiglii), however, is a drastic used only in extreme cases. It is given in doses of 1 minim (0.06 Cc.), one minim of this oil being equivalent to one drop. Croton oil is of special advantage with the insane because of the smallness of the dose and the fact that good results can be obtained if it is merely dropped on the tongue. It may be given on sugar or a piece of bread. **Castor oil** (oleum ricini) except for its taste is one of the most satisfactory cathartics in medicine. Its dose is 4 fluidrams (16 Cc.) and it acts in from two to six hours. Its taste is disguised in a variety of ways, the purpose of all being to get the oil down the throat without its coming in contact with the taste organs. It should be prepared in a small glass to reduce as much as possible the chance of contact with the lips. The usual method is to place the oil between two layers of some aromatic liquid, such as orange juice. Another palatable method of

preparing this oil is to fill a glass with a foaming flavored carbonated water, then pour the oil into the middle of it. The whole must be taken at once. Children sometimes take castor oil alone without objection. If they will not, it may be prepared for them in the form of a syrup. Castor-lax and risiccol are two preparations on the market in which the oil is in a powder form. Castor oil is best taken before breakfast.

Resinous Cathartics.—The resinous cathartics are **elaterin, jalap, colocynth, gamboge,** and **scammony.** The first two are the only ones much used alone: all except the first are ingredients of Compound Cathartic Pills. These are all highly irritating, should never be given to children or to pregnant women, and, if given over a continued period, tend to cause constipation. **Elaterin** is the most powerful drug known for the production of watery stools. Such a cathartic is called a hydragogue and has special use in dropsy and uremia. It is likely to be followed by a general depression from the excessive loss of fluids. Its dose is $\frac{1}{10}$ of a grain (0.006 Gm.). The triturate is official, dose $\frac{1}{2}$ grain (0.03 Gm.). The **resin** of **jalap** and a **Compound Jalap Powder** are official. The dose of the former is 2 grains (0.1 Gm.); of the latter, 30 grains (2 Gm.).

On Colon.—The cathartics which act chiefly on the colon are **phenolphthalein** and the familiar ones, **senna, cascara, rhubarb,** and **aloes.** The last four of these drugs owe their activity to derivatives of anthracene, a hydrocarbon obtained from coal tar, and they are often spoken of as the anthracene cathartics.

Phenolphthalein (see Fig. 9, page 128) is a white powder which in an alkaline solution, such as soapy water, produces a red color. Its cathartic properties were discovered as a result of its use as a dye in red wines. Its dose is from 1 to 8 grains (0.06 to 0.5 Gm.).

Senna leaves are much used for home-made infusions and they enter into the composition of numerous cathartic preparations. The *Compound Infusion of Senna* (Black Draught) contains also Epsom salts. Its dose is 2 ounces (60 Cc.) and it acts in about four hours. Senna is the active ingredient in Compound Licorice Powder, Syrup of Figs, a chocolate-coated confection called Tamar Indien, and many other proprietary laxatives.

Cascara sagrada (Rhamnus Purshiana) is a medicinal bark from small trees grown on the Pacific coast. The trees are killed by the barking, approximately 200,000 trees being destroyed annually to supply the world's trade. The name of this drug is Spanish, meaning sacred bark, and it is said to have originated from the first use of the medicine by monks. Cascara seems to produce the nearest to a natural action of the bowels of any of the cathartics and is the best for a continued administration. The *aromatic fluidextract* and the *extract* are the commonly used preparations, the dose of the former being 10–30 minims (0.6–2 Cc.). The latter is used in pills. They are best taken at bedtime.

The medicinal **rhubarb** plant resembles our common garden pie-plant but is a larger species grown in China. There is record of its use in that country in 2700 B.C. Besides the cathartic principle of rhubarb, which predominates in ordinary preparations, it also contains

tannin which tends to cause a subsequent constipation. There are many preparations of rhubarb (rheum).

Fig. 17.—Cascara sagrada. Five-year-old tree. From *U. S. Bulletin* 139, American Medicinal Barks.

The *aromatic tincture,* dose 30 minims (2 Cc.), and the *aromatic syrup,* dose 2 *fluidrams* (8 Cc.), are much used and are best taken at bedtime. The Mixture of

Rhubarb and Soda (this also contains ipecac as a mild beneficial irritant) is indicated in cases of indigestion rather than as a cathartic.

Aloes, a highly irritating cathartic, is the dried juice of a cactus plant of East Africa. It increases the blood supply of the pelvic organs and if long continued tends to cause hemorrhoids. It should therefore never be used in pregnancy or when hemorrhoids already exist. A bedtime dose should be accompanied by some light food as this drug should never be taken on an empty stomach. The activity of aloes is due to **aloin,** a neutral compound which is less irritating than the crude drug and somewhat less active. Aloes is a good laxative but an undesirable

Fig. 18.—Aloes plant. Growing in the New York Botanical Garden, Bronx Park, New York City.

purgative because large doses cause severe griping. Belladonna is often combined with it to offset this action. The dose of aloes as a laxative is ½ to 1 grain (0.03 to 0.06 Gm.); as a purgative, 2 to 5 grains (0.1 to 0.3 Gm.). The dose of aloin is 1 grain (0.06 Gm.). This is sometimes used in very small doses to cure chronic constipation. Aloin is the cathartic ingredient of A. S. & B. Pills (aloin, strychnine and belladonna), also of Lady Webster's dinner pill.

Enemas.—An enema may produce catharsis in three ways: (1) by increasing the bulk of the bowel content; (2) by lubricating hard feces in the lower bowel with olive oil, glycerin, or water; and (3) by an irritant action of ingredients in the enema such as strong soap or glycerin.

ON WHOLE INTESTINE.—*Saline Cathartics.*—The saline cathartics act upon the whole intestine and produce catharsis by salt action as a result of which the intestinal wall is stimulated and the content of the bowel increased in bulk. The common salines are **magnesium sulphate** (Epsom salts[1]), ½ ounce (15 Gm.); **sodium phosphate,** 30 grains (2 Gm.); and **magnesium citrate,** 6–12 ounces (180–360 Cc.) of the solution. They should be given about one-half hour before a meal, well diluted in cold water or followed by copious amounts of water to lessen the chance of absorption. A number of deaths have been reported from the absorption of magnesium sulphate which had been administered as a cathartic. If given as stated above the salines cause a free evacuation without pain in from one

[1] Named from Epsom, an English coast town, where it was first obtained. Its first source was sea weed.

to two hours. If given concentrated, they are likely to produce nausea, griping, and general discomfort for several hours. A very mild laxative saline is a **Seidlitz Powder,**[1] the official name for which is Compound Effervescing Powder. The cathartic salt in this powder is potassium and sodium tartrate (Rochelle salt[2]). Sodium bicarbonate and tartaric acid, the other ingredients, cause the effervescence and to avoid their interaction the powder is prepared in two papers; a blue paper containing the cathartic salt and sodium bicarbonate and a white paper the tartaric acid. When preparing a powder for administration the contents of the two papers are dissolved separately in water and the solutions mixed just before being given to the patient. If these powders have been long exposed to the air their effervescence is lost.

Physostigmine.—In extreme cases of paralysis of the intestines, such as may occur after abdominal operations, physostigmine salicylate is sometimes used, the probable action of which is to stimulate the muscular walls of the intestines. (See Fig. 11, page 138.) It is a marked central depressant and at times causes collapse. It is given subcutaneously in doses of $\frac{1}{60}$ of a grain (0.001 Gm.).

Sulphur and Mineral Oil.—Two well-known mild cathartics which affect the whole intestine are **sulphur** and **mineral oil.** They both act by softening the bowel content and cause practically no irritation. Pure **sulphur** mixed with molasses and potassium bitartrate

[1] Named from a German apothecary who first made this preparation.

[2] Named from the town of Rochelle, France, where it was first made.

(cream of tartar) is a household remedy, but more palatable preparations are tablets of sulphur and potassium bitartrate and the Compound Licorice Powder. **Mineral oil** is an oily petroleum product similar in composition to vaseline. Other names for this oil are Albolene or Russian oil and liquid petrolatum. It is of special use in chronic constipation and is given frequently in combination with a stronger cathartic like cascara. The dose is 1 ounce (30 Cc.) two or three times a day.

Degree of Action.

Cathartics may be classified roughly according to the degree of action as follows:

Laxative: Sulphur, mineral oil, Seidlitz powder, compound licorice powder, olive oil, and the first four purgatives in small doses.

Purgatives: Castor oil, calomel, podophyllin, mercury, jalap, physostigmine, phenolphthalein, and the anthracene group.

Drastics: Purgatives in large doses, croton oil, and elaterin.

Table of Cathartics.

Cathartic.	Approximate Time for Action.		Time to be Given.
Olive oil.	12	hours.	Before meals.
Croton oil.	½– 2	"	Before meals.
Castor oil.	2 – 6	"	Before meals.
Elaterin.	½– 3	"	As ordered.
Jalap.	3	"	Before meals.
Senna.	10 –12	"	Bedtime.
Comp. inf. of senna.	4	"	Before breakfast.
Rhubarb.	10 –12	"	Bedtime.
Cascara.	10 –12	"	Bedtime.
Aloes.	10 –12	"	Bedtime.
Salines.	1 – 2	"	Before breakfast.
Calomel.	4 – 8	"	Bedtime or as ordered.
Mercury.	4 – 8	"	Bedtime.
Podophyllin.	10 –12	"	Bedtime.
Physostigmine.	½– 3	"	As ordered.
Sulphur.	10 –12	"	Bedtime.
Mineral oil.	12	"	Two hours after meals.

Antidiarrheics.

The name antidiarrheics explains the purpose of these drugs. In cases of diarrhea laxative foods must be avoided and fluids restricted. The foods which are most constipating are arrowroot or flour gruels, boiled milk, toasted crackers, rice and hard-cooked egg albumen. When diarrhea, such as the summer diarrhea of children, is due to excessive acidity in the alimentary tract, neutralization by alkalies is the rational remedy. **Lime-water** or **sodium bicarbonate** may be used or **chalk**, the alkaline carbonate of calcium, in the form of *Compound Chalk Powder* or *Chalk Mixture.* Chalk Mixture is a flavored mixture of the Compound Powder in water. It will keep not over a week and should be made fresh whenever wanted. The dose of the powder is 30 grains (2 Gm.); of the mixture, 4 drams (16 Cc.).

Bismuth acts as an antidiarrheic by forming a protective coat over the mucous membrane. This checks the secretions of the intestinal wall and prevents irritation by the bowel content. A black sulphide is formed which colors the feces black. The salts of bismuth commonly used in medicine are the *subcarbonate, subnitrate,* and the *subsalicylate.* The dose of the subcarbonate is 7½ grains (0.5 Gm.), of the subnitrate 15 grains (1 Gm.), of the subsalicylate 4 grains (0.25 Gm.). Bismuth enters into dusting powders for its protective and slightly antiseptic action. Dermatol, xeroform, bismal and others are new preparations of bismuth (see N. N. R.). For bismuth in Röntgentherapy, see page 301.

Tannin (page 84) is an old remedy for diarrhea which has been practically displaced by bismuth. Oak and dogwood bark, chestnut leaves, yellow dock, blackberry leaves, sumach berries, kino, krameria, and numerous other drugs may be classed as antidiarrheics because of their tannin content. Tea and claret are constipating beverages. Hamamelis, the popular external remedy, contains tannin and is a weak astringent. The synthetic tannin compounds on the market are legion.

Anthelmintics.

Action.—Anthelmintics are drugs used to destroy worms of the gastro-intestinal tract. As these drugs are highly toxic and have to be given when conditions for absorption are at their best, the presence of worms must be determined *beyond a doubt* before the drugs are administered. The procedure in dealing with the tapeworm is first to lower its vitality by reducing the protein in the diet and by giving irritating foods. A fast of twelve to twenty-four hours is then prescribed and at the end a saline cathartic given. After free evacuation the anthelmintic is given on an empty stomach. These drugs only temporarily paralyze the worm and must be followed by a saline cathartic to carry it away.

Description.—For tapeworm the remedy is **aspidium** (male fern) in the form of the oleoresin. The dose is regulated by the sex, age, and general condition of the patient. For round worms **santonin** is given, coarse crystals being preferred to a fine powder to lessen the

danger of absorption. Often a simple cathartic will carry off ordinary pin- or threadworms. **Calomel, lime-water, intestinal antiseptics** and **infusion** of **quassia** are also given. As pinworms live mostly in the lower bowel, enemas of the infusion of quassia, common salt, $\frac{1}{2}$ ounce to 1 pint (15 Gm. to $\frac{1}{2}$ L.), or turpentine, $\frac{1}{2}$–1 ounce to 1 pint (15–30 Cc. to $\frac{1}{2}$ L.), are given.

The routine treatment in the United States for hookworm has been **thymol** given in small repeated doses. **Thymol** is a vegetable drug chemically allied to phenol and its iodide is known as aristol (page 236). It has recently been shown that **oil of chenopodium** is effective against hookworms. Chenopodium, a common weed known as American wormseed, has long been used as an anthelmintic against all intestinal worms and in the Orient it is preferred to any other drug in the treatment of hookworm. Three doses of the oil from 8–16 minims (0.5–1 Cc.) each are given at intervals on an empty stomach and the last dose is followed in two hours by castor oil. It is dangerous in excessive doses.

CHAPTER XVI.

EXCRETORY SYSTEM.

The classes of drugs which act upon the excretory system are of two groups, those which affect excretion by the skin and those which alter the condition of the urinary organs.

DRUGS WHICH ACT ON THE SKIN.

Excretion by the skin may be increased (1) by stimulating the endings of the nerves which control the sweat glands or (2) by increasing the blood supply of the cutaneous vessels. It is diminished by creating an opposite effect. Drugs which increase the secretion of sweat are called **diaphoretics** (synonyms: sudorifics and hidrotics). Those which decrease it are the **anhidrotics.**

Diaphoretics.

Diaphoretic measures are used chiefly to relieve the kidneys in nephritis and to remove edema in dropsy. They have some use in eliminating poisons and reducing fevers. Hot packs, hot baths, hot drinks, and vigorous exercise are diaphoretic agencies valuable under varying conditions. The last three are common remedies for the purpose of breaking up a cold. The object

of each is to relieve a localized congestion by increasing the circulation and excretion of the skin. Hot packs are more extreme measures having the same purpose.

Pilocarpine.—The one important diaphoretic drug is pilocarpine (see Myotics). Pilocarpine stimulates the endings of the same nerves affected by atropine, namely, those which do not pass through the sympathetic system, and it is used in therapeutics for its action on the eye and on the sweat glands. The pupil of the eye is contracted and the excretion of the sweat gland increased (see Fig. 11, page 138). The chief danger connected with the internal administration of pilocarpine is suffocation caused by excessive excretion in the bronchi. Large doses depress the heart. The salts used internally are the hydrochloride and the nitrate, the common dose being $\frac{1}{6}$ of a grain (0.01 Gm.). Doses as small as $\frac{1}{60}$ of a grain (0.001 Gm.) are in some cases sufficient.

Symptoms of overdosing by pilocarpine are contracted pupils, flushed face, wheezy, labored breathing, and a slow pulse. The treatment is hypodermic injections of atropine, artificial respiration, and stimulants.

Minor Diaphoretics.—**Morphine** in the form of Dover's Powder is a mild diaphoretic if given with hot drinks (see page 106). **Ammonium acetate** also has a mild diaphoretic action by dilating the peripheral bloodvessels, and it slightly increases the flow of urine by salt action. It is a good remedy for children. The common preparation is the *Solution of Ammonium Acetate,* the adult dose being 4 drams (15 Cc.). **Basham's Mixture** (page 165) is useful in chronic

nephritis because of the action of this drug on the kidneys. The **Spirit of Nitrous Ether**, a solution of ethyl nitrite in alcohol, is a popular diaphoretic and diuretic in colds and fevers. It is frequently combined with ammonium acetate. Sweet Spirits of Niter is a popular name for this preparation. The dose is 30 minims (2 Cc.).

Anhidrotics.

Local measures for decreasing the excretion of sweat are sponging in strong alcohol or in solutions of vinegar or alum. Internal remedies are indicated chiefly in the night-sweats of tuberculosis. The strongest anhidrotic for internal use is **atropine**. The disadvantage of its use is the accompanying dryness of the throat. A drug similar in action is **agaricin**, an extract of a fungus of European larch trees. Its effect is fleeting but without the annoying side actions of atropine. Another anhidrotic is **camphoric acid**, an oxidation product of camphor. Night-sweats of tuberculosis are thought to be due to a slight asphyxia. Camphoric acid relieves this by stimulating the respiratory centre. It has a very disagreeable taste and is given in a capsule or cachet in doses of 15 grains (1 Gm.).

DRUGS WHICH ACT ON THE URINARY ORGANS.

The classes of drugs which are used for their action on the urinary organs are urinary antiseptics, diuretics, and antilithics.

Antiseptics.

Urinary antiseptics are indicated in general septic conditions, in pyelitis (inflammation of the pelvis of the kidney), in cystitis, urethritis, and infections by organisms such as colon bacillus and gonococcus.

Hexamethylenamine.—The drug most used under ordinary conditions as a urinary antiseptic is hexamethylenamine (héxa-méthylen-ámine). Some of the patented names for this drug are urotropin, formin, and ammoform. Hexamethylenamine is made by combining formaldehyde and ammonia and its value is due to a liberation of these substances in the urine. It has been tried as an antiseptic for the respiratory tract and the cerebrospinal fluid but with doubtful results. In mild septic cases, such as in abscesses and feverish colds, it is reputed to relieve the systemic conditions. Hexamethylenamine has no antiseptic effect on the urine unless the urine is acid in reaction. To ensure this acid condition sodium acid phosphate is frequently administered alternately with hexamethylenamine. The dose of hexamethylenamine is 5 grains (0.3 Gm.). Helmitol is a proprietary compound of hexamethylenamine and citric acid.

Miscellaneous Drugs.—Other urinary antiseptics are **salol, uva ursi, buchu, cubebs, oil of santal,** and **copaiba. Salol** has already been studied (see page 185). The others all owe their activity to volatile oils. **Uva ursi** is a leaf drug, especially efficient against colon bacillus. The *fluidextract,* dose 30 minims (2 Cc.), and the *infusion* are used. **Buchu,** another leaf drug, is

best given as an infusion. There are buchu tablets on the market which when dissolved in hot water make the equivalent of an infusion. **Cubebs** are small berries which contain a resin as well as a volatile oil. The oil and oleoresin are both used in doses of from 5 to 20 minims (0.3–1.2 Cc.). The **oil of santal** is distilled from santalwood (sometimes spelled sandalwood). Its dose is 8 minims (0.5 Cc.). Arheol, Carbosant, Santyl, and Thyresol are trade names of chemical derivatives of this oil which are claimed to be less irritating to the gastro-intestinal tract than the oil itself. **Copaiba** is an oleoresin sometimes incorrectly called balsam of copaiba. It is excreted by the bronchial mucous membranes, the kidneys, and the skin. Its excretion through the skin sometimes causes eruptions; its passage through the bronchial membrane makes it an expectorant. Its greatest use, however, is as a urinary antiseptic. It is given in capsule or in an emulsion in doses of 15 minims (1 Cc.), and frequently with the spirit of nitrous ether, cubebs, or the oil of santal. Uva ursi, cubebs, and copaiba are all used as antiseptics in gonorrheal infections of the bladder and urethra.

Diuretics.

Diuretics are drugs which cause an increase in the flow of urine. They may do this in four ways:

1. By direct stimulation of the secreting cells.
2. By irritation of the secreting cells.
3. By improving the circulation of the glomeruli.
4. By decreasing resorption of fluids from the tubules.

Briefly stated the solids of the urine are excreted chiefly by the cells lining the tubules. The fluids are exuded chiefly from the blood as it passes through the glomeruli and these fluids in flowing through the tubules wash down the excreted solids.

1. **Stimulation.**—Caffeine (page 93) and theobromine produce diuresis by pure stimulation without irritation. **Theobromine** is an alkaloid closely allied to caffeine and it has a similar action on the kidneys and

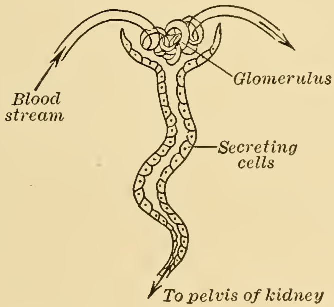


Fig. 19.—Schematic diagram of kidney tubule.

the heart without such marked stimulant effects on the central nervous system. It is of special value in dropsy. It is derived from cacao nuts or shells or made synthetically.[1] The medicinal salts of this alkaloid are theobromine sodium salicylate (**diuretin**) and theobromine sodium acetate (**agurin**). The purpose of the sodium salt in these compounds is to make them more

[1] Cacao nuts also yield chocolate and cocoa which should be called cacao. Cocoanut trees yield cocoanuts. Coca plants yield cocaine.

soluble. **Theophyllin** (trade name, theocin), a similar synthetic diuretic, is more powerful than theobromine but less permanent in action. Theobromine and theophyllin tend to produce gastric disturbances and are given in capsules or well diluted in water. The dose of theobromine is about 7½ grains (0.5 Gm.), of theophyllin about 4 grains (0.25 Gm.), given in warm tea.

Theobromine is sometimes given in the form of cocoa, a cup of the best cocoas containing about 1½ gr. (0.08 Gm.) of the drug.

2. **Irritation.**—The irritant diuretics are **calomel** and the urinary antiseptics already studied, **buchu, oil of santal, cubebs, copaiba,** and **uva ursi. Calomel** is of special use in cases of cardiac dropsy; the others when infections are present. There are a few drugs used externally which may be absorbed and cause irritation of the kidneys. They are oil of turpentine, cantharides and capsicum, common counter-irritants, and chrysorobin (Goa powder) used in skin diseases (page 248). Any sign of kidney irritation during treatment by these drugs should be reported immediately.

3. **Improvement of Circulation.**—**Digitalis** and **strophanthus** act as diuretics in dropsical conditions by improving the circulation. They are often given with caffeine. **Water** taken freely will cause diuresis by increasing the *volume* of the blood in the kidney. **Pituitary extract** produces the same result by causing vasoconstriction except in the kidneys. Certain salts increase the volume by salt action. Among the best diuretic salts are **potassium acetate,** dose 30 grains (2 Gm.), and

potassium citrate, dose 15 grains (1 Gm.). Others are the **bicarbonates of sodium and potassium, potassium bitartrate** (cream of tartar), and **ammonium acetate** in Basham's mixture. As these are all alkaline salts they are especially useful when there is excessive acidity of the urine.

4. **Prevent Resorption.**—It is probable that one cause of a diminished flow of urine is resorption of fluids from the tubules. This may be checked by a rapid flushing of the tubules and by a salt-free diet. One theory upon which this diet is based is that chlorides become stored in excess in the cells of the kidneys. To keep this excess properly diluted water is absorbed from the tubules. When sodium chloride is withheld from the diet the available source for storage is diminished and some of the excess may pass from the cells to bring the circulating fluids to a proper degree of concentration.

Antilithics.

Another disorder of the urinary system is the presence of calculi (stones). They are composed of uric acid, oxalate of lime, phosphates, and other organic compounds which normally are in solution in the urine. Some calculi are small enough to be passed in the urine, otherwise surgery is practically the only known treatment. The term, antilithics, is applied to medicines used in an attempt to dissolve stones in the kidney or bladder. Uric acid calculi tend to form in too acid urine, and alkaline salts such as potassium acetate and citrate may prevent further increase in

their size and possibly break up loosely formed ones. Phosphatic calculi are favored by too alkaline urine and inorganic acids may be of similar benefit in such cases. There is extensive advertising of mineral waters for the prevention and solution of stones, but they are mainly if not wholly without value.

CHAPTER XVII.

DRUGS WHICH AFFECT NUTRITION.

The processes of nutrition are dependent primarily on the nervous system, and any measures, hygienic or therapeutic, which improve that system improve nutrition. Another important factor in nutrition is a normal supply of the food principles necessary to the cells. A deficiency may be due to poor diet or, if the diet is well balanced, to incomplete absorption or assimilation. The whole problem is a very complex one and little is known of the action of drugs on nutritive processes.

Phosphorus.—As phosphorus is a necessary constituent of nerve tissue, it has been employed in medicine as a nerve tonic. The fact that fish contains a comparatively large amount of phosphorus has given rise to the theory that fish is a brain food.

Action.—Phosphorus in the form of **hypophosphites** has been much used as a general tonic but it has now been proved beyond a doubt that all the hypophosphites taken by mouth are excreted unchanged, hence can have no possible systemic effect. The various syrups of hypophosphites owe their usefulness to other ingredients, such as strychnine, iron, and arsenic. **Glycerophosphates** were introduced as substitutes for

the phosphites, but there is no proof that they are any better. **Lecithin** is the compound of phosphorus which occurs in most living cells, especially nerve and brain cells, and it is one of the constituents of milk and eggs. This has been obtained pure and marketed as a stimulant to nutrition. An ordinary diet contains from 75 to 225 grains (5 to 15 Gm.) of lecithin, and probably a diet rich in milk and eggs would be as efficient as lecithin taken as a medicine. Phosphorus aids in the nutrition and growth of bone-marrow and bone cells. This results in some increase in the number of red corpuscles. It may be given in pills containing $\frac{1}{125}$ of a grain (0.0005 Gm.) of the drug, or in phosphorated oil 1:100.

Toxicology.—Large doses or continued local contact with phosphorus cause necrosis of the bone, known among match factory workers as "phossy jaw." Through the magnanimity of the Diamond Match Company in making public their process of using non-poisonous phosphorus and by stringent legislation this disease is being eliminated in industry. The chemical antidotes for phosphorus are potassium permanganate and copper sulphate. Oil should be avoided in cases of poisoning as it increases the absorption of the drug.

Calcium.—Calcium is a normal constituent of the body the lack of which causes soft bones, possibly excessive permeability of the bloodvessels and nervous conditions such as tetany, convulsions, and epilepsy. This drug is being very much studied at the present time. When given by mouth it is absorbed slowly

and in small amounts. Calcium chloride, lactate, and hypophosphate are given by mouth and attempts are being made to find a suitable salt and method for subcutaneous injection.

Iodides.—The iodides are considered in this class of medicines because they have the power of favorably modifying cellular activity. They are frequently and correctly called "alteratives." They have the following uses in therapeutics:

1. In tertiary syphilis (see page 219).
2. In arterial diseases resulting from syphilis.
3. In emphysema and chronic bronchitis as expectorants (see page 177).
4. In aneurysm of the aorta, arteriosclerosis, and other cases of high arterial tension.
5. In some forms of goitre.
6. In certain infectious diseases in which exudates form in the tissues.
7. In cases of poisoning by the heavy metals such as lead and arsenic.

Action.—Practically all the diseases above mentioned are characterized by the formation of some kind of exudates or abnormal cells and the iodides cause these to disappear. The value of the iodides has long been established but their method of action is still not understood. It has been suggested that these disorders may be caused by a deficiency of the internal secretion of the thyroid gland which contains iodine, and that the iodides are remedial by stimulating that gland. Other explanations are that the beneficial cellular changes are due to the presence in the cells of free iodine liberated

from the iodide, or to the formation of some ferment which destroys the abnormal formations.

Dosage.—The iodides of potassium and of sodium are the ones commonly used. For non-syphilitic treatment they are given in doses of from 5 to 30 grains (0.3–2 Gm.). Often saturated solutions are used, 1 minim of which is equivalent to one drop and contains 1 grain of the iodide. A course of iodides is begun with a dose of about 5 drops and increased daily. Iodides should not be given on an empty stomach. The common method of their administration is in or with milk. If in tablet form the tablets must be dissolved before they are swallowed. *By whatever method given the iodides must be well diluted.* To prevent the metallic taste often present in the mouth during a course of iodides, a gargle of sodium bicarbonate may be used.

Toxicology.—The untoward actions of the iodides produce a condition spoken of as "iodism." It is characterized by coryza, salivation, and skin eruptions. An important preventive measure is extreme cleanliness of the skin and mucous membranes.

Thyroid Gland.—**Action.**—Thyroid gland is a true stimulant to metabolism. The official preparation, **Desiccated Thyroid Glands**, obtained from sheep, is a yellowish powder. It is now an extablished fact that the activity of any thyroid gland preparation runs parallel with the amount of iodine contained in it. The commercial standard requires an iodine content of not less than 2 per cent. Therapeutic doses of this medicine cause an increase in the katabolism of fat and protein and a corresponding loss of weight. For

this reason it has been used to reduce obesity. Its results are not permanent and unless protein is very much increased in the diet it tends also to reduce strength. Beneficial results have been reported from the use of thyroid gland in marasmus, rickets, softening of the bones, delayed union of fractures, and in other diseases characterized by disordered nutrition. The greatest use of thyroid gland in therapeutics is to supply thyroid secretion when the gland has been removed or is atrophied and in two diseases, myxedema and cretinism, caused by inactivity of the gland.

Dosage.—Medication is usually started in doses of 1 grain (0.06 Gm.), three times a day, and gradually increased. During the administration the patient should avoid exertion and have a diet rich in protein. There is on the market a triturate of the active principles of the thyroid gland called **iodothyrin** or **thyroiodine** but results from its use have been variable.

Remedies for Hyperthyroidism.—By hyperthyroidism is meant excessive activity of the thyroid gland such as occurs in exophthalmic goitre. A theory has been advanced that the thyroid gland secretes certain toxins which in normal animals are neutralized by other substances in other parts of the body. If then, on this theory, the glands be removed from an animal, the neutralizing substances will accumulate in the blood and this blood will act as an antidote in other animals suffering from hyperthyroidism. There are in use two preparations from the blood of sheep from which the thyroids have been removed, antithyroidin-Moebius and thyreoidectin. Another remedy is

Beebe's serum, a serum from animals which have been immunized against thyroid.

Antipyretics.—One of the products of nutritive processes is heat, and when the cellular or central mechanisms are so deranged as to cause excessive heat production or to prevent sufficient heat loss a condition results which is called fever. Any measures, nursing procedures or drugs, used to lessen fever are said to be antipyretic. Fever is now recognized merely as a symptom and in infectious diseases as a protective condition in which antibodies are formed to counteract toxins. Unless, therefore, the temperature is very high no attempts are made to lower it except for the purpose of making the patient more comfortable.

Antipyretic Measures.—The object of antipyretic nursing procedures, such as **fan baths** and **baths** of tepid water or alcohol with much friction, is to quicken the circulation, bring more blood to the surface of the body, and thus increase *heat loss.* The administration of diaphoretics, such as **hot drinks, Dover's powder, ammonium acetate,** and **spirit of nitrous ether** have the same purpose. Pilocarpine, notwithstanding its power to cause excessive sweating, tends to raise the temperature.

Antipyretic Drugs.—The drugs which have some use as antipyretics are the **coal-tar analgesics, quinine,** and **aconite.** The coal-tar analgesics act by depressing the heat centre. The heat centre is now considered rather a coördinated mechanism and the exact method by which this mechanism controls body temperature is not known, but it is probable that when it is depressed

heat production is decreased. The difficulty, however, in using drugs to depress this mechanism is that they also affect the vital centres and cause a general depression. Phenacetine, antipyrine, and acetanilid are especially depressing to the heart if given continuously in long fevers, but they are used to some extent. They relieve the nervousness which accompanies a high fever and are resorted to in cases in which baths cannot be given. **Quinine** is commonly employed as an antipyretic in the early stages of coryza. From 2 to 4 grains (0.1–0.25 Gm.) every four hours will frequently break up a cold. **Aconite** is safe only in short, acute fevers and is being used less and less even in such cases, because of its toxic action on the heart (see page 157).

CHAPTER XVIII.

SPECIFICS.

A SPECIFIC is a medicine which by a highly selective action destroys some one organism in the body without harming the host. The serums will be considered in Chapter XXVIII. In this chapter will be described **quinine**, the specific against malaria; **mercury** and **arsenic** used against syphilis; **emetine** against amebic dysentery and the **salicylates** as antirheumatic remedies. It is not definitely known that rheumatism is caused by a germ, but the salicylates are very specific in their action in this disease.

Quinine.

History.—Quinine is an alkaloid derived from cinchona bark. Cinchonas are large, beautiful forest trees native to Bolivia and Peru but almost none of the bark now comes from wild trees. The cultivation of the cinchonas for medicinal purposes is at the present time carried on extensively in Java and India. The properties of this bark were said to have been learned from the natives by Spaniards who conquered Peru in the 17th century. The origin of its name is given in the story that the wife of a Spanish viceroy, Countess of Chinchon, was the first European to be cured of

malaria by this new remedy and on recovery she gave away large quantities of the bark. For some strange reason there was much opposition to its use in England and it was not accepted in the medical profession until quack doctors had conclusively proved its value. Its alkaloid, quinine, is now being used exclusively.

Action.—Its action was not understood until the life-history of the malarial organism was learned. These organisms develop in the stomachs of a certain species of mosquito, and when this insect bites a person the organisms pass into the blood stream along with the mosquito's saliva. In the blood of the host one form of the organism, the asexual, sporulates, that is, breaks up into spores, very resistant little bodies which continue the life-cycle of the organism. During sporulation toxins are given out which cause the characteristic chills of malaria. It is at this stage that the organisms are most susceptible to quinine and if the drug is given 1 to 3 hours before an expected chill so that the blood is saturated with it at the time of sporulation the chill may be prevented.

Administration.—Quinine bisulphate and hydrochloride are the salts to be preferred as they are the most soluble. Hypodermic injections of the hydrochloride of quinine and urea are also used. The usual dose of any quinine salt is 4 grains (0.25 Gm.), but in malaria 10 grain (0.6 Gm.) doses may be given. In malarial districts huge doses are taken daily as a prophylactic with no apparent ill effects. Warburg's Tincture and Antiperiodic pills are National Formu-

lary preparations used in malaria which are typical "shotgun prescriptions." They contain twenty different ingredients. For administration to children the bitter taste of the medicine is disguised by making the insoluble tannate of quinine into chocolate-coated tablets called "quinine chocolates," or by giving it in the fluidextract of licorice or a syrup of yerba santa, a drug which makes the taste organs unable to appreciate the bitter taste.

Other Uses.—Minor uses of quinine are (1) as a gastric tonic, often in the form of cinchona preparations; (2) as a scalp stimulant in eau de quinine and other hair tonics; (3) as a uterine stimulant in labor; (4) as an antipyretic and analgesic in neuralgia and colds; (5) and in certain skin diseases.

Cinchonism.—Large doses of quinine produce a condition called *cinchonism,* which is characterized by ringing of the ears, a sense of fulness in the head, and dizziness. The bromides relieve these symptoms.

Other Alkaloids of Cinchona.—Cinchona contains besides quinine the alkaloids quinidine, cinchonine, and cinchonidine, all of which have the same action as quinine in malaria, but they are no better, are more expensive, and some are depressant.

Antisyphilitics.

Mercury.—**Action.**—In spite of new and much-lauded remedies, mercury still remains the one reliable specific in syphilis. Its action, so far as is now known, is to destroy the germs. It is thought that it may also

hasten the absorption of the products of inflammatory processes caused by the organisms.

Administration.—The most common methods of administering mercury as an antisyphilitic are by mouth, by inunction, and by hypodermic injection. By whichever method given, the procedure is to give as much as can be borne (called mercurializing the patient) and to continue the treatment at intervals over a period of two years.

By Mouth.—For administration by mouth, the salts most commonly employed are the **protoiodide** (HgI, yellow iodide) and the **biniodide** (HgI_2, red iodide). Mercuric bichloride ($HgCl_2$) and potassium iodide KI) given together form the biniodide in the body. For a course of mercury in children the Gray Powder (mercury with chalk) is frequently used. The protoiodide is usually given in a pill starting with $\frac{1}{4}$ grain (15 mg.) daily. The dose of the biniodide is about $\frac{1}{20}$ grain (3 mg.) daily.

By Inunction.—For inunctions the **Dilute Ointment of Mercury** (blue ointment) is the preparation most used. The parts best adapted for absorption of the drug by this method are the axilæ, groins, chest, back and abdomen, a different part being chosen on successive days. An infant can be easily mercurialized by putting the ointment under the flannel binder. Before the treatments are begun a thorough general bath should be taken and before each treatment the part to which the ointment is to be applied must be thoroughly cleansed with hot soap and water. A general bath is then allowed only once a week.

By Injection.—When mercury is administered by injection, it is given intramuscularly into the buttock. By this method a depot is established from which there is slow absorption. The salicylate or benzoate of mercury are the salts usually given by this method, and they are given in suspensions in liquid paraffin. The injections are repeated every two or three days. They almost always leave a local bruise and may cause headaches. This method is by far the cleanest and the most exact, and some physicians consider it the only way by which sufficient mercury can be introduced into the system.

Untoward Actions.—The sign that a patient has had all the mercury he can bear is soreness of the gums. Some very susceptible people have skin eruptions, salivation, and deranged digestion from therapeutic doses. As a prophylactic in mercurial treatment, the mouth should be washed out twice daily with some astringent solution, such as a solution of potassium chlorate, tannin, or tincture of myrrh, and except when inunctions are being given the skin must be kept thoroughly clean by daily baths.

Toxicology.—The first symptoms of acute mercury poisoning are corrosion of the mouth, esophagus and stomach, vomiting, and pain in the abdomen. The first-aid treatment is white of egg or milk followed by lavage. Demulcents and symptomatic treatment should then be given. Death is most frequently due to injury of the kidney through which the metal is excreted.

Salvarsan.—Origin and Action.—Investigators have long believed that arsenic would be a specific against syphilis if some compound could be found which could be given in sufficiently large doses to kill the germ without poisoning the patient. A number of organic preparations were made, such as atoxyl (sodium arsanilate), arsacetin (sodium acetyl arsanilate), arsenophenylglycin, and sodium cacodylate, but their value is very doubtful. Dr. Ehrlich, a German investigator, thoroughly convinced that some such compound could be found, carried out a series of experiments which ended in the discovery of **salvarsan**, called "606" because it was the 606th compound made and tested in his series of experiments. The details of the composition of salvarsan are too complex to be explained here but the one vital characteristic of the compound is that each arsenic atom has one unattached bond which, according to Ehrlich's theory, is like an empty hand reaching out and destroying the germs. Its graphic formula may be represented simply as follows:

```
        group of        group of
        elements        elements
           |               |
    germ—As————————————————As—germ
```

Neosalvarsan is a still more complex compound made in an attempt to avoid some of the disagreeable and dangerous side actions of salvarsan. They are both yellow powders kept in sealed tubes to prevent decomposition, and are unsafe for use after longer exposure to the air than is necessary to prepare them for administration.

Administration.—These drugs are administered intravenously in sterile solutions. Salvarsan is given in saline, and, as it is strongly acid, is neutralized by the addition of small amounts of sodium hydroxide. Neosalvarsan is neutral in reaction and is given in solution in water. The dose has to be carefully regulated to suit the individual case, the average being 10 grains (0.6 Gm.). When these remedies are given in the early stages of syphilitic infections sometimes a single dose will kill all the germs. This is not always the case, however, and often they are given in repeated weekly doses and in conjunction with mercury. The great advantage of their use is prompt removal of acute symptoms such as rashes and sores, thus lessening the chance of contagion. The disadvantage is that a patient, judging by external evidence, thinks he is cured and, regardless of microscopical evidence, contaminates others by marriage or conception of children. It is now an accepted fact that in most cases the two-year course of mercury must be taken, and, in the later stages of the disease, only mercury is of any value.

Up to January, 1914, 214 deaths had been reported from the use of salvarsan and neosalvarsan. Frequent after-effects are headaches, nausea, and languor.

Other Uses.—These drugs are specifics also in two tropical diseases which are caused by microörganisms, relapsing fever and frambesia (yaws). They are being tried in malaria and in the disorders usually treated by arsenic trioxide.

Salicylates.

Action.—As the cause of rheumatism is not known, the method of action of the **salicylates** cannot be explained. Their activity is due to the liberation of salicylic acid. It is very probable that the acid is excreted into the synovial fluids in the joints and thus

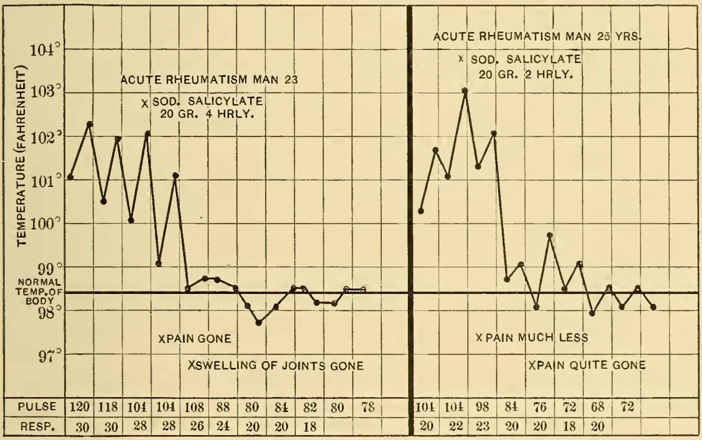


FIG. 20.—Clinical charts of cases of acute rheumatic fever treated with salicylate of sodium. Case 1, 20 grains every four hours; Case 2, 20 grains every two hours. (Stockman.)

relieves articular rheumatism. The salicylates may also favor the excretion of uric acid. They markedly dilate the cutaneous bloodvessels, causing an increase in sweating and consequent lowering of temperature. A course of salicylates in acute rheumatism may make a patient exceedingly uncomfortable, because the large doses given in such cases often cause salicylism,

a condition of excessive sweating, ringing in the ears, deafness, extreme fulness in the head, and gastric irritation with nausea and vomiting.

Minor Uses.—The salicylates are used as analgesics in neuralgia and headaches, and as antiseptics in eye diseases, but they have no such decided action in these cases as in rheumatism.

Dosage.—Sodium salicylate is the salt most used in medicine. The dose is 15 grains (1 Gm.) and in acute cases this is repeated every hour until salicylism is produced. It must be given in dilute solution or with a copious drink of water if in capsule or cachet.

Substitutes.—Substitutes for sodium salicylate are **aspirin** (page 131), **novaspirin, salicin** (a glycoside from willow trees), and **methyl salicylate.** Methyl salicylate (see page 139) is made synthetically from phenol, and because of traces of phenol left in it, the synthetic drug acquired a bad reputation. When properly made it is exactly as good as the natural product. The dose is 15 minims (1 Cc.) taken well diluted and when the stomach is not empty. **Mesotan** is a synthetic compound of this drug used for local applications.

Atophan.

Atophan is a new synthetic remedy for gout and rheumatism which is still in the experimental stage. It produces a prompt excretion of uric acid without affecting the amount of urine. To prevent the formation of uric acid calculi in the bladder sodium bicarbonate is frequently given with it. The dose is about

15 grains (1 Gm.) given with large quantities of water. Much larger doses may be given in acute cases.

Emetine.

Recent experiments have proved emetine, one of the active principles of ipecac, a specific in amebic dysentery. This disease, an infection of the intestines and liver by the amœba dysenteriæ, is common in the Philippines and other tropical countries but rarely seen in this country. The hydrochloride is given subcutaneously in doses of $\frac{1}{2}$–1 grain (0.03–0.06 Gm.). It is without value in other forms of dysentery.

CHAPTER XIX.

REPRODUCTIVE SYSTEM.

Drugs which affect the reproductive system may be divided into two groups: those which act upon the uterus in menstrual disorders or in labor, and those which stimulate or depress the sexual function.

DRUGS WHICH AFFECT SEXUAL FUNCTION.

Very little is known about drugs of this group. Those which stimulate the sexual function, as in cases of impotency, are called aphrodisiacs; those which depress it are called anaphrodisiacs and are indicated in cases of excessive irritability of the sexual organs.

Aphrodisiacs.—In general the treatment in impotency is to remove the cause and by hygienic living and general tonics, such as **strychnine**, **iron** and **arsenic**, to improve the general condition of the system. The drugs which are tried in such cases are irritants. **Cantharides** (Spanish flies) is frequently used but is dangerous on account of its irritant action on the kidneys. Ginseng, a drug which has a reputation in China as a specific in impotency, if used at all in this country, is given as a stomachic.

Anaphrodisiacs.—In the case of excessive irritability the procedure is to remove the cause, decrease the

blood supply in the sexual organs by cold applications, and to depress the nerves by such drugs as **atropine** and **hyoscyamus.**

DRUGS WHICH ACT ON THE UTERUS.

Emmenagogues.

Drugs which increase the menstrual flow are known as emmenagogues. They are indicated in cases of dysmenorrhea and absence of menstruation from various causes. Simple procedures which are effectual are hot foot or sitz baths, counter-irritants, such as a hot-water bottle or turpentine stupes over the uterus, and hot vaginal douches. General tonics are useful in improving the circulation. Strong purgatives will increase the blood supply of the uterus.

Pennyroyal, tansy, savin, and rue are common herbs which were used in household medicine as emmenagogues and not infrequently to produce abortion. Each of them contains a highly irritating volatile oil which in large enough doses to cause abortion produces dangerous if not fatal results. For this reason many States have laws restricting the sale of the drugs or their oils.

Uterine Sedatives.

There are numberless preparations on the market which are purported to relieve menstrual pains. Most of these contain **viburnum,** a popular name for which is

cramp bark. Other ingredients are cohosh, hydrastis, pulsatilla, Jamaica dogwood, and wild yam (dioscorea). The value of viburnum and these other herbs in such disorders has no support in clinical experience. Their wide use seems based on the fact that aborigines used them for such troubles, or on their successful exploitation by shrewd advertisers. Some of the preparations put out by the large drug firms are Elixir of Viburnum Compound, Elixir of Hydrastis and Cramp Bark Compound, Fluid Extract of Cramp Bark, Mother's Cordial, and Uterine Sedative Elixir.

On the theory that the ovaries excrete some internal secretion which is necessary to the function of menstruation, experiments have been made with **extract** of **ovaries** and of the **corpus luteum**, a glandular body in the ovary which has a definite relation to ovulation. The best results have been obtained from these in relieving the nervous symptoms of menopause, either natural or postoperative.

Ecbolics.

Drugs which are given to check the menstrual flow or to increase the contraction of the uterus for the purpose of checking postpartum hemorrhage are called ecbolics. **Extracts of the mammary gland** have been tried with some success for this purpose in young girls and at the menopause. **Hydrastis** and **hydrastinine** are of value in menstrual hemorrhages. In the hemorrhage following labor, **epinephrine** and **pituitary extract** are used to some extent but the drug of greatest value

PLATE III

Claviceps Purpurea—Ergot of Rye.

(Courtesy of Parke, Davis & Co.)

is **ergot** in the form of a fluidextract. The action of ergot depends on its several active principles which cause contraction of the uterine muscles, thus mechanically closing the ends of the bleeding arterioles. The dose of the *fluidextract* is 30 minims (2 Cc.). It should not be given until just after delivery. No one of the active principles of ergot fully represents the action of the crude drug (see page 160).

CHAPTER XX.

DRUGS WHICH ACT ON SKIN AND MUCOUS MEMBRANES.

Counter-irritants.—Counter-irritants are therapeutic agents applied to the skin for the purpose of relieving some deep-seated affection. When used only to the degree of producing redness, they are termed *rubefacients;* if they produce a blister they are called *epispastics;* if the irritation continues to the point of destroying the superficial tissues, they are termed *caustics.*

Counter-irritation relieves the affection of the organ over which it is applied by reflex nerve relation between the skin and the organ, and by producing a change in the blood supply of the organ. The mental effect of the substitution of a new and superficial pain also assists in the result. The agents for counter-irritation are **heat, friction, cupping,** and **drugs.**

Physical Measures.—*Heat* may be applied *dry* by means of a hot-water bag, electric pad, a thermocautery, hot flannels, or heated bags of inert substances such as bran, flaxseed meal, flour, or bread. The object in all these measures is to maintain a high degree of heat over a considerable period of time.

Heat is applied *wet* in the form of stupes or a clay poultice. Stupes may be wrung out of hot water

alone, but more often oil of turpentine is added. The turpentine is mixed with about 4 parts of some bland oil (with 6 to 10 parts for children) and smeared over the surface which is to be covered by the wet cloths. The application is renewed between every two or three stupes according to the degree of redness produced. Wet stupes have a more penetrating action than dry heat, and addition of the volatile oil of turpentine still further increases the power of penetration.

The official clay poultice (trade name, antiphlogistine) is a mixture of kaolin (clay), glycerin, and several aromatic and mildly antiseptic substances, oil of peppermint, thymol, and boric acid. It is of value as a means of retaining heat and it reduces swelling by abstracting water from the tissues.

Friction is seldom used alone but should accompany the application of all liniments. *Cupping* is a purely mechanical method of reddening the skin by stretching it through suction, and temporarily increasing the blood supply in the area covered by the cup. In extreme conditions, such as pneumonia, edema of the lungs, and suppression of urine, recourse is sometimes had to this form of counter-irritation.

Drugs.—The drugs employed as counter-irritants are **ammonia, chloroform, turpentine, camphor, menthol,** and **capsicum** in liniments, and **mustard, capsicum** and **cantharides** in poultices or plasters. Their value depends on the volatile and irritating properties of the drugs. Because of their penetrating power, the action of these drugs does not stop on removal from

the surface. Therefore, when a blister is not desired, any application of the more irritating ones, the last three, must be removed before its full effect is obtained.

Rubefacient.—**Mustard** is a counter-irritant because of the volatile oil of mustard which is formed when mustard is mixed with *tepid* water. It is used as a rubefacient but will form a blister if not sufficiently diluted or if in contact with the skin too long a time. **Capsicum** (cayenne pepper) has a similar action. Mustard is prepared for use as a counter-irritant in the form of a leaf, paste, or poultice. The leaf is purchased ready for use and has merely to be dipped in tepid water before application. A mustard paste is made by mixing with tepid water, mustard and flour in the proportion of one part mustard to about four parts of flour (1 to 10 for children). To prevent blistering the white of an egg may be added to the paste or the surface of the skin covered with oil or vaseline. The skin must be watched and the paste removed when a good degree of redness is obtained. It requires from five to fifteen minutes. A mustard poultice is made by mixing with tepid water mustard and flaxseed or linseed meal in the proportion of one part mustard to six or eight of meal (1 to 10 or 12 for children).

Epispastics.—Blistering is being used less and less as a therapeutic agent because of the pain of the treatment and the fact that it prevents for a long time further applications over the same area. Cantharides (Spanish flies) is the most common epispastic and a

fly-blister is produced by application of the cerate of cantharides spread on a piece of cloth. The blister appears in from five to ten hours and must be very carefully dressed as it is extremely susceptible to infection. Fly-blisters are occasionally used at the base of the brain to prevent effusion and over joints with effusions.

Caustics—Caustics are employed to destroy abnormal growths such as warts, cankers, and granulations on wounds or the eyelids. It is very important in applying caustics to touch only the affected part. Their use at best is very painful and limited to small superficial areas. **Silver nitrate** in the form of a stick or in strong solutions is a familiar caustic. Organic compounds of silver and weak solutions of silver nitrate are valuable as antiseptics and astringents. (See Disinfectants, page 237.) Another caustic is **chromium trioxide,** CrO_3, sometimes called chromic acid. It is a powerful oxidizing agent and is used in medicine in the form of a stick or in solution. **Pyrogallol** is a highly irritant caustic (see page 128) used in fungous skin diseases, often in combination with zinc oxide. **Copper sulphate** in the form of a crystal, pencil, or in solution (0.1 per cent.) has special use as a caustic in trachoma. After its application the eye should be washed with warm water. For acids as caustics, see page 71.

Disinfectants.

Skin disinfectants are used in parasitic skin diseases, in septic sores, in fresh wounds to render them aseptic,

and to sterilize an area for minor operations. For application to the skin the most important disinfectants are **mercury, sulphur, tar, iodine, sodium hypochlorite**, and certain coal-tar antiseptics. Those used on mucous membranes are **iodine, hydrogen peroxide**, the **salts of silver, boric acid**, and numerous mixtures.

Disinfectants Used on the Skin.

Mercury.—Mercury is applied in the form of ointments or lotions. Mercurial ointment, dilute mercurial ointment (blue ointment), and ointment of ammoniated mercury (white precipitate ointment), are used for ordinary skin diseases; the ointment of mercuric nitrate for ringworm and venereal sores; and the ointment of yellow mercuric oxide for eye treatments. Black wash (solution of calomel in lime-water) and yellow wash (a solution of bichloride of mercury in lime-water), are used for treatment of venereal sores.

Sulphur.—Sulphur disinfects by forming with the secretions of the skin sulphides which render the skin soft and aseptic. As the reaction is slow, the action of the drug is gradual and prolonged. Sulphur is known as washed sulphur, precipitated sulphur, or sublimed sulphur, the difference between the three forms being the method by which they are purified. It is used in pure form or in an ointment for scabies and other skin diseases. **Ichthyol** is a sulphur compound of unpleasant odor obtained from the fossils of fishes.

It has been prepared synthetically in an odorless form called **thiol**. The action of these compounds is not understood. They are used in solution or ointment to reduce inflammation in sunburn, infections, erysipelas, glandular and joint diseases.

Tar.—Next to mercury and sulphur as skin disinfectants is tar (pix liquida), an oleoresin obtained by distillation of pine wood. It has been said that the skill of a physician in treating skin diseases depends upon his skill in using tar. Besides being disinfectant, it is a stimulant to the cells and a prolonged use without interruption causes a high degree of inflammation. It should be used with care on the axilla and face, and it should not be applied over any large area. The tar should be removed when the inflammatory state begins and applied again after it has subsided. A nurse should report the degree of inflammation. The oil and ointment of tar are used. The oil of cade, a tar from juniper having less unpleasant odor, is often used as a substitute.

Iodine.—Iodine, in the form of the *tincture*, has recently come into extensive use for the disinfection of fresh wounds and for sterilization of the skin before minor operations as well as for treatment of skin diseases. Because of its volatility it penetrates below the surface and as it enters into combination with the cell constituents it has a lasting effect. If the application of the tincture of iodine causes too severe burning, it can be washed off with alcohol. Iodine *ointment* is the form commonly used in diseases of the skin.

Iodoform is a yellow powder, a compound of iodine having a very disagreeable odor, which is disinfectant to abraded surfaces only. There have been cases of systemic poisoning caused by the application of iodoform gauze over large areas. Under such conditions vomiting or cerebral excitement or depression should be promptly reported. Numerous compounds have been made in an attempt to find an odorless substitute for iodoform.

Aristol (thymol iodide), iodol, and europhen are iodine compounds used as antiseptic dusting powders. They are related to phenol and resemble it in action more than they resemble iodine. (See other compounds of iodine in N. N. R.).

Coal-tar Antiseptics.—*Phenol* is one of the most familiar of this group. It has great power of penetration into the tissues and in this respect is superior to certain other antiseptics, such as bichloride of mercury, for its action on bacteria, but it is so toxic to the cells that its use is limited. A continued application of even very weak phenol ointment on an open wound or of compresses wet in weak phenol solutions not infrequently causes gangrene. Serious results have occurred from the latter method of treating a mild infection on the advice of a nurse. Phenol slightly paralyzes sensory nerve endings and for this action is used in certain skin diseases as an antipruritic (a drug which allays itching). (See Fig. 11, page 138.) The absorption of phenol may be detected by a dark, smoky urine, a slight cerebral excitement, and at times kidney irritation. Phenol is a powerful central

depressant and in large doses causes almost instant collapse. *Resorcin,* another coal-tar antiseptic, has caused a number of cases of poisoning. It has a special use as an antiseptic of the scalp and is also used in lotions and ointment for the skin. Cresol (trade name, trikresol), picric acid, and pyrogallol are other useful coal-tar antiseptics (see Fig. 9, page 128).

Sodium hypochlorite ($NaOCl$) is a skin disinfectant due to the liberation of hypochlorous acid, a powerful oxidizing agent. This compound in solution is the official Solution of Chlorinated Soda, known as Labarraque's solution. It is formed when chlorinated lime and washing soda are rubbed together on the wet skin. Solutions of hypochlorous acid (0.5 per cent. or less) have recently been employed as wound disinfectants with some success.

Various **salts of zinc** are much employed in skin diseases. They are all astringents as well as antiseptics, and relieve inflammation. The *acetate* and *chloride* are used in solution, the *oxide* and *stearate* in pure form or in ointment. Very weak solutions of *zinc sulphate* are used as astringents in the eye.

Disinfectants Used on Mucous Membranes.

Iodine.—Iodine is used for painting the throat in solutions of the tincture, diluted according to the degree of action desired. **Hydrogen peroxide** or dioxide (H_2O_2) is a compound which by readily liberating oxygen disinfects surfaces with which it comes in

contact. It is much used in cleaning suppurating wounds and as a gargle. It is slightly irritant and should not be used full strength. Weak solutions of **silver nitrate** and organic silver compounds are in general use for the same purpose. The most common organic preparations are **argyrol** and **protargol**, compounds of silver and albumin. Others are albargin, argonin, novargon, silver citrate and lactate. (See N. N. R.)

Boric Acid.—Boric acid is a very mild non-irritating antiseptic having special use in irrigations of the delicate membranes of the eye, ear, and bladder. A 2 per cent. solution is commonly used.

For gargle and mouth washes there are numerous preparations in vogue, some of undoubted value, others well deserving of the name "psychic antiseptics" which has been given to them. The official **Antiseptic Solution** contains boric and benzoic acids, thymol, eucalyptol and three volatile aromatic oils and over one-quarter of the whole mixture is alcohol. This is typical of many of the proprietary mixtures, **listerine**, **glycothymoline**, and **borolyptol**, for example. It is probable that the alcohol is responsible for much of their power as disinfectants.

Lysol (see page 128) is a disinfectant used almost exclusively for vaginal douches in solutions in the proportion of one teaspoonful to a quart of water. There have been a number of cases of poisoning by lysol and recovery took place only when there was prompt lavage.

Astringents.

Action and Uses.—Astringent drugs cause at the point of application constriction of the bloodvessels, a lessened permeability of their walls, and absorption of fluids which have exuded into the tissues. Their power to produce these effects is probably due to the fact that they form with the proteins of the cells hard, insoluble compounds which pucker the tissues. They have this local action only and are used in medicine on mucous membranes to check diarrhea (page 198), to reduce inflammation in the eye, pharynx, stomach, uterus, urethra, and rectum, and to stop hemorrhage. A drug with checks hemorrhage by an astringent action is called a **styptic** in distinction from a **hemostatic** which constricts the bloodvessels by stimulating the muscles or the vasoconstrictor nerves. Astringent drugs are used on the skin to promote healing and as antipruritics.

Drugs.—**Alum** is a common astringent much used in gargles, enemas, and eye washes. It is a salt of the metal aluminium (popularly called aluminum) and contains in each molecule twelve molecules of water, called the water of crystallization. **Burnt alum** is the salt from which the water of crystallization has been expelled and it is used as a styptic. Alum gargles (from 1 to 5 per cent.) are somewhat injurious to the teeth. The **solution of aluminium acetate** has recently come into use as an astringent. It does not keep well and should be well diluted for application on the skin. Other metallic salts which have an astringent

action are **zinc oxide** as a powder or an ointment, **tincture of ferric chloride**, and a solution of **lead subacetate**. The last is the active ingredient in the lead and opium wash much used in inflammatory conditions such as ivy poisoning. **Tannin** in any form acts as an astringent on the skin as well as on the mucous membranes.

Styptics.

The common styptics are **ferric chloride, burnt alum,** the **tannins, absolute alcohol**, and, in an emergency, powdered or granulated sugar which is antiseptic and promotes healing. Epinephrine is the best local hemostatic.

Vulneraries.

Wounds.—Vulneraries are medicines applied to open wounds to promote healing. They disinfect the wound, stimulate the surrounding tissues, and form a protective covering. Their use is limited chiefly to treatment of suppurating wounds and old ulcers. The **balsam of Peru**, a common vulnerary, is a natural exudation from a tree of the West Indies. The natives apply it at once to fresh wounds. It is a thick brown liquid used in the pure state. The tinctures of **myrrh** and **benzoin** are also used for this purpose, the latter pure, the former diluted five to ten times with water.

Burns.—Common first-aid treatment for burns is **Carron oil,**[1] a mixture of equal parts of lime-water and

[1] The name is derived from a town in Scotland where this remedy was first used for treatment of the many cases of burns among workmen in the foundries.

linseed oil. This is not a sterile preparation and should not be used when extensive areas have been blistered. It is applied on cloths and left on only until the burning sensation subsides. Another remedy used for burns is **picric acid,** a phenol derivative. Gauze can be secured which has been saturated in a solution of picric acid and dried. This is moistened, applied directly to the burn, and left on for several days. This drug may be absorbed and cause general depression, therefore it should not be used over large areas or on children. Simple first-aid remedies for burns are wet compresses of **sodium bicarbonate** or of **salt solution.** For later treatment sterile **vaseline** and **boric acid** ointment are used.

PART V.

MISCELLANEOUS TOPICS.

CHAPTER XXI.

SUGGESTED TOPICS FOR REVIEW.

1. Acids and alkalies.

(*a*) Action in alimentary canal.
(*b*) Local uses.
(*c*) Effect on urine.
(*d*) Precautions in their administration.

2. Salts.

(*a*) Which metallic salts are poisonous, and why?
(*b*) Enumerate important remedies the effects of which are due to salt action.

3. Name the important active principle of the following drugs and state in which case it represents the action of the crude drug:

Nux vomica.	Ergot.	Hyoscyamus.	Digitalis.
Opium.	Physostigma.	Coca.	Adrenal gland.
Belladonna.	Cinchona.	Ipecac.	Hamamelis.

4. Give four therapeutic uses of volatile oils.

5. What is the therapeutic action of resins? To what class of medicines do resinous drugs chiefly belong? Cautions as to their use.

6. To what is the activity of the following drugs due:

Iodoform.	Urotropin.	Lecithin.
Amyl nitrite.	Salol.	Salvarsan.
Ammonium carbonate.	Aspirin.	Argyrol.
Ammonium chloride.	Ichthyol.	

7. Give the first-aid chemical antidote for the following:

Sulphuric acid.	Digitalis.
Arsenic.	Bichloride of mercury.
Ammonia water.	Copper sulphate.
Oxalic acid.	Phenol (internally and externally).
Morphine.	Silver nitrate.

8. Name the active ingredients of the following:

Dover's powder.	Blaud's pills.	Hive syrup.
Paregoric.	Basham's mixture.	Blue ointment.
Comp. acetanilid powder.	Fowler's solution.	Thiersch's solution.
Hoffmann's anodyne.	Comp. licorice powder.	Seidlitz powder.
	Comp. mixture of licorice.	Gray powder.

9. Give the drugs for which the following are popular names:

Spirit of glonoin.	Blue mass.	Aristol.
White precipitate.	Diuretin.	Adrenalin.
Laudanum.	Theocin.	
Epsom salts.	Urotropin.	

10. Give characteristic symptoms of overdosing by the following:

Acetanilid.	Quinine.
Atropine.	Morphine.
Aconite.	Sodium bromide.
Strychnine.	Potassium iodide.
Copper sulphate.	Mercury.
Arsenic.	Sodium salicylate.
Chloral hydrate.	Digitalis.
Tartar emetic.	

11. Name drugs which are antagonistic in action to the following:

Pilocarpine.	Alcohol (systemic action).
Morphine.	Epinephrine (on bloodvessels).
Homatropine (in eye).	

12. What change would be expected in the rate and force of the pulse beat after an administration of the following?

Strychnine.	Veratrum.
Ether (inhalation).	Epinephrine (intravenously).
Digitalis.	Chloral hydrate.
Aconite.	Iron.
Caffeine.	Morphine.

13. What special points should be observed in preparing and administering a dose of the following?

Hydrochloric acid.	Aromatic spirit of ammonia.
Sodium salicylate.	Saline cathartics.
Charcoal.	Paraldehyde.
Potassium iodide.	Sulphonal.
Tincture of ferric chloride.	Castor oil.
Dover's powder.	Croton oil.
Hoffmann's anodyne.	Nitroglycerin.

14. By what method are the following drugs given (mouth, inhalation, injection, and so on)?

Apomorphine.	Morphine.
Pituitary extract.	Quinine and urea hydrochloride.
Tincture of benzoin.	Cocaine.
Mercury.	Homatropine.
Ammonium chloride.	Stramonium.

15. Give the dose of the following:

Strychnine as stimulant.	Apomorphine (as emetic).
Atrophine as stimulant.	Chloral hydrate.
Caffeine.	Phenacetine.
Morphine.	Potassium iodide.
Paregoric.	Tincture of digitalis.
Spirit of nitroglycerin.	Fowler's solution.

16. Name six commonly used drugs which tend to produce a drug habit.

17. Give the popular names for the following drugs:

Phenyl salicylate.	Thymol iodide.
Hexamethylenamine.	Spiritus frumenti.
Sodium and potassium tartrate.	Liquor potassii arsenitis.
Potassium bitartrate.	Calcium hydroxide.
Magnesium sulphate.	Calcium carbonate.

CHAPTER XXII.

DRUGS OF MINOR IMPORTANCE.

Adonis Vernalis.—Action similar to digitalis. The dose of the fluidextract is 1–2 minims (0.06–0.1 Cc.). Its active principle is a glucoside adonidin, dose $\frac{1}{10}$ grain (0.006 Gm.).

Agar-agar.—A substance obtained from sea weeds which will absorb water and form a jelly. Extensively used as a culture medium in bacteriology. Used in medicine to cure constipation, its action being to start peristalsis by increasing the bulk of the bowel content. Prepared in powder or in shreds either of which may be taken alone or mixed with food. The dose is $1\frac{1}{4}$–4 drams (5–15 Gm.). The action may not appear for several days, but when it starts daily administration will produce daily soft natural stools.

Anise (incorrectly called Anise seed).—A drug whose activity is due to a volatile oil. The oil of anise is aromatic and has a mild carminative and expectorant action. It is contained in paregoric and various cough mixtures chiefly as flavor, and is useful as a carminative for young children. The dose is 3 minims (0.2 Cc.).

Apinol.—A compound derived from the distillation of pine wood. Used externally on wounds and sores as an anodyne and a vulnerary; internally for catarrh of the digestive tract; by inhalation as an expectorant.

Apiol.—A derivative of the seeds of garden parsley. Used in doses of 2–5 grains (0.1–0.3 Gm.) as an emmenagogue, and 4–15 grains (0.25–1 Gm.) as an antipyretic.

Apocynum (dogbane).—A drug with digitalis action but it is not well absorbed. The dose of fluidextract is 2–10 minims (0.1–0.6 Cc.).

Arnica.—Used in the form of the tincture in liniments for bruises and sprains, and as an antiseptic and stimulant in wounds.

Aspidosperma.—Resembles apomorphine in action; used occasionally as an expectorant. Fluidextract $\frac{1}{4}$–1 dram (1–4 Cc.).

Betanaphtol.—A coal-tar derivative. Used externally in ointments as an antiseptic and as an anthelmintic in hookworm disease; internal use dangerous because if absorbed to any extent nephritis results. The dose is 2–5 grains (0.1–0.3 Gm.).

Boneset.—A common wild herb used in the form of a fluidextract or "boneset tea" as a diaphoretic home remedy to break up colds and fevers.

Bromipin.—A bromine derivative of sesame oil; a substitute for the bromides claimed to be more lasting in action and to be less likely to produce bromism. Prepared in 10 per cent. and $33\frac{1}{3}$ per cent. solutions. The dose of 10 per cent. is 1 dram (4 Cc.); of $33\frac{1}{3}$ per cent., 20 grains (1.3 Gm.). In epilepsy the dose may be two to eight times as large.

Bromoform ($CHBr_3$).—A compound similar in composition to chloroform ($CHCl_3$), bromine being substituted for chlorine. An antispasmodic limited in therapeutics to whooping-cough. A powerful narcotic and should be handled with care. The adult dose is 5 minims (0.3 Cc.) dissolved in alcohol or oil. It requires about 5 drops to obtain 1 minim of bromoform.

Cannabis.—A narcotic poison used by drug habitués in India under the name of "hashish;" has been tried as a hypnotic, but undesirable because of danger of habit formation. Official preparations are tincture, dose 8 minims (0.5 Cc.), and extract, dose $\frac{1}{5}$ grain (0.01 Gm.).

Catechu (gambir).—Because of tannin content is an astringent. Compound tincture 1–2 drams (4–8 Cc.).

Chloralformamidum (chloralamide).—Compound of chloral, claimed to be less depressant to the heart. The dose is 15–30 grains (1–2 Gm.) in powder, capsule, or elixir.

Chloretone.—A compound of chloroform which has been tried as a preliminary to ether as an anesthetic. Used in powder or solution as a local sedative on ulcers or decayed teeth, and as an antiemetic in cases of persistent vomiting.

Chrysarobin.—A yellow powder used as an antiseptic and stimulant in skin diseases, especially in chronic cases (page 206). More powerful than tar. Used in ointment or solution. It stains the skin, hair, nails, and clothing, but can be removed from the latter by dilute solution of sodium hydroxide (caustic soda) or Labarraque's solution.

Colchicum.—In form of a tincture, a remedy for acute gout; of little value in rheumatism. Large doses cause nausea and purging. The dose is 30 minims (2 Cc.).

Convallaria (Lily of the Valley).—Resembles digitalis in action, but is much more poisonous. Fluidextract, 10 minims (0.6 Cc.).

Copper Sulphate.—In dose of $\frac{1}{5}$ grain (0.01 Gm.) is used occasionally as an intestinal astringent in cases of chronic diarrhea.

Creolin.—A proprietary mixture of cresol in soap solution, similar to Compound Cresol Solution (U. S. P.). Used as antiseptic in ointments, in irrigations, and for wet dressings. Solutions must be made with warm water.

Cusso.—Anthelmintic used for tapeworm. The dose is 1–4 drams (4–16 Gm.).

Dionine.—A derivative of morphine used to some extent as a substitute for it in mild cases. Used locally in certain eye diseases to produce a vasodilatation.

Duboisine.—An alkaloid similar to atropine in action. Used as sedative for the insane. Dose is $\frac{1}{100}$–$\frac{1}{40}$ grain (0.6–1.5 mg.).

Euphthalmin.—A substitute for atropine used in eye examinations; action is prompt and not prolonged.

Fennel.—A carminative, the action of which is due to its volatile oil.

Frangula (Buckthorn).—A cathartic resembling cascara.

Gelsemium (Yellow Jasmine).—A central depressant used sometimes as an analgesic in facial neuralgia; also a mydriatic. Its active principle is an alkaloid, gelseminine.

Ginger (Zingiber).—In the form of the tincture used as gastric tonic and carminative. Dose of tincture, 30 minims (2 Cc.).

Glauber's Salt (Sodium sulphate).—Dose 2 drams (8 Gm.) as a saline cathartic.

Grindelia.—An expectorant. Fluidextract, 30 minims (2 Cc.).

Guaiacum.—A resin from guaiac wood thought to have some use as an alterative. Whatever good may result probably due to slight stimulation of the gastro-intestinal tract. Tincture, dose 1 dram (4 Cc.); ammoniated tincture, 30 minims (2 Cc.).

Hops.—A mild nerve sedative; active principle is lupulin.

Hormonal.—A liquid extract derived from the spleen of the rabbit at the height of the digestive processes; claimed to possess the power of exciting peristalsis when given intravenously or intramuscularly. It is still in the experimental stage.

Hydrastis.—Resembles strychnine as a general tonic and ergot as an emmenagogue, especially at menstruation. On mucous membranes it is used as an astringent to reduce chronic inflammation as in catarrh and gonorrhea. One of its active principles is an alkaloid, hydrastine, and from it an artificial alkaloid, hydrastinine, is derived which is an emmenagogue. Dose of fluidextract, 30 minims (2 Cc.); of tincture, 1 dram (4 Cc.); of hydrastine, $\frac{1}{5}$ of a grain (10 mg.); of hydrastinine hydrochloride, $\frac{1}{2}$ of a grain (30 mg.). For local treatment the fluidextract is used (1–8 parts of water) or the tincture (1–2 parts of water). Cotarnine, a derivative of narcotine, popularly called Stypticin, and hydrastinine are practically identical in action.

Hydriodic Acid.—A 10 per cent. solution in water sometimes given in doses of 1 dram (4 Cc.) for the same purposes as an iodide.

Lobelia (Indian Tobacco).—Used as antispasmodic in asthma. Fluidextract, 2 minims (1.3 Cc.). Overdoses causes nausea and collapse.

Lugol's Solution.—Compound solution of iodine; an aqueous solution suitable for injections of iodine.

Manna.—A saccharine exudation from a species of ash tree which acts as a weak laxative. It contains 90 per cent. of mannite, a peculiar sugar which by salt action increases the bulk of the bowel content.

Matricaria (German chamomile).—Action as carminative due to its volatile oil. Also used with large quantities of hot water as a home remedy to break up colds and as an emmenagogue.

Oil of Cloves.—An antiseptic volatile oil sometimes used as a carminative and frequently in dentistry as an anodyne. For insertion in a cavity it may be used on cotton in full strength. The dose is 3 minims (0.2 Cc.) on sugar or in finely cracked ice.

Oil of Theobroma (Cacao Butter).—A fixed oil used as a lubricant in massage, as a soothing application to sore nipples, and as a base for suppositories.

Orthoform.—A benzoic acid derivative used externally pure, in powders and in ointments as an antiseptic and anodyne.

Pelletierine Tannate.—A mixture of tannates of the alkaloids of pomegranate used as an anthelmintic. The maximum dose is 5 grains (0.3 Gm.); large doses cause paralysis.

Phytolacca (Poke Root and Berries).—The root and berries used popularly as cathartics and alteratives; active principles not known.

Piperazine.—A synthetic drug of doubtful value as an antirheumatic.

Pumpkin Seed (Pepo).—Used in an infusion as anthelmintic in cases of tapeworm.

Saccharin.—Derivative of benzoic acid used as a substitute for sugar in diabetes. Has no food value; tends to derange digestion. The dose is 3 grains (0.2 Gm.).

Salophen.—A derivative of salicylic acid used as an antirheumatic.

Sanguinaria (Bloodroot).—An ingredient of cough mixtures used as an expectorant.

Sarsaparilla.—A drug long valued as a spring tonic. Its only active ingredient is a saponin which may have some slight stimulating action on the stomach. Compound Syrup of Sarsaparilla is useful as a vehicle for castor oil and other drugs.

Scoparius (Broom Top).—Has a diuretic action. The dose is 15 grains (1 Gm.).

Senega.—An expectorant. The dose is 15 grains (1 Gm.).

Sparteine.—An alkaloid, the action of which on the heart resembles that of aconite. The dose is variously given from $\frac{1}{5}$–$1\frac{1}{2}$ grains (0.01–0.1 Gm.).

Spigelia.—Anthelmintic for roundworm.

Staphisagria.—Also called stavesacre, larkspur, and delphinium. Much used as parasiticide for head lice in the form of the tincture, pure or mixed with equal parts of ether. It is a systemic poison resembling aconite and toxic symptoms are similar.

Tragacanth.—A gum resembling acacia; its mucilage used as base in many pharmaceutical preparations.

CHAPTER XXIII.

PRESCRIPTIONS.

A PRESCRIPTION is a written order from a physician to a pharmacist to supply the patient with medicines prepared in certain forms. It includes also directions to be written on the label of the bottle in regard to the time and method of applying or taking the medicine. It is the duty of the physician to make his directions clear and accurate. The pharmacist checks up the prescription and consults the physician if there is any doubt as to its meaning or accuracy. He must know the best method by which prescribed preparations can be made and usually the choice of vehicle and coating for pills is left to him. The physician, and particularly the pharmacist, must know what drugs are incompatible—that is, cannot be prescribed together because of some chemical reaction that would take place between them.

It has always been the custom for prescriptions to be written in Latin but at the present time there is a strong tendency to use English. The advantage of the use of Latin is that it is frequently desirable to conceal from the patient the nature of the medicine. In certain mental and nervous conditions a very mild remedy with a long unfamiliar Latin name frequently

does more good than a familiar one which is more drastic. Some patients fancy that they cannot take certain medicines but take them willingly under their Latin names. A doctor has to be very tactful in thus deceiving his patient and should discriminate carefully between a fancy and an idiosyncrasy. The disadvantages of using Latin are that many physicians use it in bad form, sometimes dubbed "hog Latin," and that in most cases a patient has a perfect right to know what he is taking.

Whatever system of weights and measures is used, it is understood that solids are measured by weights and liquids by liquid measure. When the metric system is used the tendency is to write only the figures, it being understood that whole numbers are grammes or cubic centimeters and that decimals are fractions of these. In haste a decimal point might easily be made to look like the figure 1, and to avoid any confusion a line is drawn where the points would be as is shown in the following prescription:

For George Bennet August 20, 1914.

℞—Strychnine sulphate,	0 | 015
Aloin,	0 | 2
Extract of belladonna,	0 | 06

M. and make into 10 pills.
Sig.—Take one at bedtime.

Dr. G. K. Rose.

The quantities are 0.015 Gm. of strychnine sulphate, 0.2 Gm. of aloin, and 0.06 Gm. of the extract of belladonna. The symbol ℞ at the beginning of the prescription stands for the Latin word "recipe," meaning "take thou." If Latin is used the names of the ingredients are in the genitive case, which corresponds

to the possessive case in English. The prescription above would be as follows in Latin:

For George Bennet	August 20, 1914.
℞—Strychninæ sulphatis,	0|015
Aloini,	0|2
Extracti belladonnæ,	0|06
Misce et fiant pilulæ No. x.	
Sig.—Take one at bedtime.	
	Dr. G. K. Rose.

This reads: Take 0.015 Gm. of strychnine sulphate, 0.2 Gm. of aloin, 0.06 Gm. of the extract of belladonna, mix and make into ten pills. The form of most Latin words is so similar to the English that one who has never studied the language can usually tell without difficulty what is meant. There are a few abbreviations familiarity with which will enable a nurse to understand a prescription. As a rule, the first part of a word is used for its abbreviation, for example, "syr." for syrup, "tinct." for tincture.

M.	=	misce, mix.
Ft.	=	fiant, make.
Pil.	=	pilula, pill.
Cap.	=	capsula, capsule.
Chart.	=	chartula, paper.
Aq.	=	aqua, water.
āā	=	ana, of each.
q.s.	=	quantum sufficiat, as much as may be required.
Sig.	=	signa, write on label.
a. c.	=	ante cibum, before meals.
p. c.	=	post cibum, after meals.
Stat.	=	statim, at once.

q. h. = quaque hora, every hour.
q. 2 h., 3 h., 4 h. = every 2, 3, or 4 hours.
o. d. = omni die, daily.
b. i. d. = bis in die, twice a day.
t. i. d. = ter in die, three times a day.
4 i. d. = four times a day.
p. r. n. = pro re nata, when required.
s. o. s. = si opus sit, when required.
c. = cum, with.
s. = sine, without.
ad = up to.
et = and.

P. P. on the top of a prescription means poor patient, and is a request to the pharmacist to make the lowest possible price.

Ne rep. (ne repetatur) on a prescription indicates that it is not to be refilled.

The following prescriptions illustrate the form used for different preparations. For convenience the date and names of patient and doctor are omitted.

(1) ℞—Tinct. gentianæ comp., ℥iij
Sig.—ʒj a. c.

(2) ℞—Sodii bicarb., ʒiss
Tincturæ gentianæ comp., ℥ss
Tincturæ quassiæ, ʒij
Syrupi zingiberis, q. s. ad ℥ij
M. et Sig.—ʒj q. 2 h., for gastric pain.

(3) ℞—

Bismuthis subnitratis,	4	00
Zinci oxidi,	1	00
Glycerini,	5	00
Phenolis,	0	60
Petrolati albi (white vaseline),	90	00

M. et ft. ungt.
Sig.—For ivy poisoning.

(4) ℞—Olei ricini, ♏xxx
Phenylis salicylatis, gr. xxx
M. et ft. in cap. No. xii.
Sig.—One capsule q. 4 h.

(5) ℞—Tinct. digitalis, 30 Cc.
Sig.—Take 1 Cc. o. d.

(6) ℞—Cretæ præparatæ,
Sodii bicarbonatis, āā 15 Gm.
M. et ft. in chart, No. xx.
Sig.—One powder in glass of hot water t. i. d. 2 hr. p. c.

(7) ℞—Hydrargyri iodidi rubri, 0 | 25
Extracti nucis vomicæ, 1 | 00
Ferri lactatis,
Quininæ bisulphatis, āā 4 | 00
M. ft. pil. No. lx, coat.
Sig.—One pill p. c. for gastric acidity.

(8) ℞—Extracti belladonnæ, gr. iss
M. in oleum theobromatis q. s. ad. suppos. No. vi.
Sig.—Insert 1 suppos. b. i. d.
ne rep.

(9) ℞—Vini erythroxyli, ℥iv
Sig.—Take ʒij stat. et q. 4 h. for vomiting.

(10) ℞—Antipyrinæ, gr. xlviij
Sodii bromidii, ʒij
Codeinæ, gr. v
Syr. rubi idæi (raspberry), ℥ij
Aq. destil. (distilled), q. s. ad ℥iv
M. et Sig.—ʒi q. 4 h.

(11) ℞—Ampulæ amylis nitritis, ♏iij, No. xii
Sig.—Break in towel and inhale p. r. n.

(12) ℞—Sodii salicylatis, ʒj
Ft. cachetæ No. xii.
Sig.—1 cachet q. h.

CHAPTER XXIV.

EXPERIMENTS.

Apparatus required for one desk. (Two students can easily work together).

6 test-tubes.	Square of gauze, 8 by 8.
Mortar ($4\frac{1}{2}$ in.) and pestle.	Gas burner.
Glass funnel ($4\frac{1}{2}$ in.).	Gold beater's bag or parchment thimble.
Ring stand with at least two rings.	8 oz. beaker.
100 Cc. cylindrical glass measure.	16 oz. beaker.
10 Cc. cylindrical glass measure.	Test-tube rack.
Evaporating dish.	Glass cover for large beaker.
Glass stirring rod.	Water-bath.
Filter paper (three pieces of 7 in.).	

If regular laboratory equipment is not easily available the last five articles can be dispensed with by using ordinary dishes and any kind of a double boiler arrangement for a water-bath. The cost of the chemicals and drugs required for a class of twelve will be about two dollars.

I. True Solutions and Suspensions.

(*a*) Fill two test-tubes about half-full of water. Put a few grains of chalk into one and the same amount of sodium bicarbonate into the other. Agitate both. Compare results at once and after standing.

(*b*) Take about 10 Cc. of water in one test-tube, 10 Cc. of alcohol in another. Drop a few drops of some oil into each. Agitate and compare results as above.

II. Effect of Heat on Solubility.

Put into two test-tubes 10 Cc. of water and 8 grains (0.5 Gm.) of boric acid. Heat one to boiling and agitate

both for several minutes. Note the difference in the amount of acid dissolved. When it is all dissolved the solution will be saturated at ordinary temperatures. To the hot solution add another 8 grains (0.5 Gm.) of boric acid and agitate until dissolved. Let it cool and note the precipitate at the bottom of the tube. However much may be dissolved in the water when hot after cooling it will hold only 8 grains (0.5 Gm.) of the acid.

III. Pharmaceutical Preparations.

The purpose of the exercises is to give a practical knowledge of the nature of the different preparations. No nurse should consider herself competent to make these or other preparations for actual use as medicines unless she has had special training under a licensed pharmacist.

1. **Water.**—Make Cinnamon Water, U. S. P., using half the quantities. The purpose of the talc is to separate the oil, which is very slightly soluble in water, into finely divided particles, so that as much of it as possible comes in contact with the water and enters into solution.

2. **Solution.**—Make Solution of Potassium Arsenite (Fowler's Solution) by the following recipe:

Arsenic trioxide,		1 Gm.
Potassium bicarbonate,		2 Gm.
Comp. tr. of lavender,		3 Cc.
Water,	q. s.	100 Cc.

Boil first two ingredients with 10 Cc. of water until solution has been formed. Add enough water to make

97 Cc. Lastly add Comp. Tr. of Lavender and filter. The chemical reaction is seen in the following equation:

$$\underset{\text{Arsenic trioxide.}}{As_2O_3} + \underset{\text{Potassium bicarb.}}{4KHCO_3} \rightarrow \underset{\text{Potassium arsenite.}}{2K_2HAsO_3} + 4CO_2 + H_2O$$

3. **Mucilage.**—Show Mucilage of Acacia as example. About four hours are required to dissolve the gum. The lime-water reacts with an acid in the gum, thus preventing fermentation and forming a product which makes a smooth consistency.

4. **Spirit.**—Make Spirit of Cinnamon, U. S. P., using $\frac{1}{50}$ of quantities.

5. **Elixir.**—Show Elixir of Iron, Quinine, and Strychnine Phosphates as example.

6. **Glycerite.**—Make Glycerite of Tannic Acid, U. S. P., using 5 Gm. of tannic acid and 16 Cc. of glycerin.

7. **Oleates.**—Show specimen of oleic acid and oleate of mercury.

8. **Collodion.**—Flexible collodion is a common example. Burn some in an evaporating dish to show its inflammability.

9. **Infusion.**—Make an infusion of buchu leaves, using 5 Gm. of leaves and 100 Cc. of water. Use gauze as strainer.

10. **Tincture, Fluidextract, and Extract.**—These require special apparatus and a long time. The processes should be demonstrated by a pharmacist. Good illustrations of the three preparations are the tincture, fluidextract, and extract of digitalis.

11. **Oleoresins.**—Show Oleoresin of Aspidium, U. S. P., as example.

12. **Emulsion.**—This is difficult to make well and should be demonstrated by a pharmacist.

13. **Mixture.**—Make Chalk Mixture, U. S. P., using half the quantities.

14. **Liniment.**—Make Lime Liniment, U. S. P., using smaller quantities.

15. **Triturate.**—Follow general directions in U. S. P., using any drug desired.

16. **Pills.**—These require special apparatus and skill and should be demonstrated by a pharmacist. Show specimens of bolus, granule, and troche. Demonstrate the difference between a tablet triturate and a compressed pill by crushing one of each.

17. **Ointment.**—Make Boric Acid Ointment, U. S. P., using $\frac{1}{20}$ of the quantities. Making ointment on a slab should be demonstrated by a pharmacist.

18. **Suppositories.**—Show examples of the rectal, vaginal, and urethral.

19. **Powder.**—Make Powder of Ipecac and Opium, U. S. P., using $\frac{1}{10}$ the quantities.

Make Granular Effervescing Sodium Phosphate by the following recipe:

Exsiccated sodium phosphate,	0	5 Gm.
Saccharated sodium bicarb.,	4	75 Gm.
Saccharated tartaric acid,	2	3 Gm.
Saccharated citric acid,	2	3 Gm.

Mix the ingredients in a mortar; transfer to an evaporating dish and heat over a water-bath (not too hot), stirring constantly with a glass rod. When granules have formed, remove the mixture from the water-bath and stir until dry. Test for effervescence,

The correct method of folding a powder paper should be taught by a pharmacist.

20. **Plasters** and **Papers** are usually made wholesale. Samples may be shown if their appearance is not familiar.

IV. Acids and Alkalies.

Make a solution of egg albumin by dissolving the white of one egg in 100 Cc. of water and straining. Put 2–3 Cc. of this in each of six test-tubes, and add the following substances all in full strength, drop by drop:

1. H_2SO_4.
2. HCl.
3. HNO_3.
4. Phenol.
5. Alcohol.

V. Salt Action.

Sugar in the form of molasses is used in this experiment because it gives very marked results.

Test the gold beater's bag to be sure that it has no hole in it. Fill it about one-quarter full of molasses and tie it securely at the top. Mark in ink on the bag the highest point which the liquid inside reaches when the bag is suspended. Place the bag in water so that the molasses is below the water line. Let stand for two hours. Then note the presence of water in the bag and the sweet taste of the water in the glass. The same principle can be shown by weighing the contents of the bag before and after immersion in the water.

If a parchment thimble is used, the procedure is the same except that it cannot be tied at the top.

VI. **Salts.**

Make a solution of egg albumin as in preceding experiment. To small quantities add, drop by drop, solutions of following:

1. $HgCl_2$ (1:1000).
2. $AgNO_3$ (10 per cent.).
3. $Pb(C_2H_3O_2)_2$ (sat. alcoholic solution).
4. $CuSO_4$ (1 per cent.).
5. $FeCl_2$ (Tr.).

VII. **Antidotes to Poisons.**

The action of a few antidotes can be nicely shown in test-tubes. Add a little lime-water to a solution of oxalic acid, some strong tea to a solution of an alkaloidal salt, some albumin solution to bichloride of mercury in solution.

VIII. **Active Principles of Plants.**

1. **Glucosides** (salicin as type in a 2 per cent. solution).

(*a*) Take about 6 Cc. of solution and test for sugar by Fehling's reagent.

(*b*) Take 25 Cc. of solution, add $2\frac{1}{2}$ Cc. of dilute H_2SO_4. Place this over a water-bath for ten minutes, then neutralize with sodium hydroxide and test this for sugar.

2. **Oils.**—Pour one drop each of oil of cinnamon and of cottonseed oil on a piece of glazed paper. Compare appearance of spot. Heat paper gently. Note change and odor.

3. **Saponins.**—Put two or three pieces of quillaja bark in water in a test-tube and shake.

4. **Alkaloids** (quinine as type).—Add 0.1 Gm. of alkaloid to 25 Cc. of water. Note solubility and reaction to litmus.

Add about $\frac{1}{2}$ Cc. of dilute H_2SO_4 to above. Shake and add more acid until the alkaloid disappears. What is formed and why did it disappear?

Put some of above in three test-tubes and test with potassium permanganate, tea, and coffee.

5. **Resins.**—Add 0.03 Gm. (gr. $\frac{1}{2}$) of a resin (podophyllin, for example) to 5 Cc. of alcohol and an equal amount of 5 Cc. of water. Compare solubility.

6. **Tannins.**—Make a strong solution of tannic acid and add some of it to a solution of albumin. What is formed?

IX. Iron Compounds.

Put in test-tubes small quantities of ferric citrate, ferratin, ovoferrin, hemoglobin, and the tincture of ferric chloride, all in solution. Drop into each a few drops of potassium ferrocyanide, a reagent which produces a blue color with free iron. Those in which this color appears are *inorganic* preparations of iron. Into the tubes where no color is obtained put a small quantity of hydrochloric acid. This breaks down the combination and frees the iron. If no color then appears some still stronger reagent would have to be used to break down the compound. The substances which have to be broken down before the blue color appears are *organic* forms of iron.

CHAPTER XXV.

LEGISLATION CONCERNING POISONS AND HABIT-FORMING DRUGS.[1]

The earliest legislation in regard to the sale of poisons in this country was enacted in New York State in 1829. It was then required that a "Poison" label be put on "arsenic, corrosive sublimate, prussic acid, or any other substance or liquid usually denominated poisonous." In 1848 New Hampshire passed a law requiring a record of the sale of the three poisons named in the New York law, and four years later Ohio required by law both a record and the "Poison" label.

As early as 1860 the evils of the opium and morphine habits were well recognized and the use of these drugs was on the increase, but in spite of the best efforts of medical men there was no legislation against their sale or use until the enactment of the Ohio Anti-opium Smoking Law in 1885. As cocaine was not discovered until 1884 its use as a habit-forming drug was not wide-spread until some years later, and the first laws prohibiting its sale *without a prescription* were passed by Illinois in 1897. Since that date, up to 1912, all

[1] For detailed information see Public Health Bulletin No. 56, "A Digest of Laws concerning Poisonous and Habit-forming Drugs." This may be secured from the Government Printing Office at Washington.

the States except Nevada, New Mexico, South Dakota, Delaware, and Vermont have followed the example of Illinois in regard to cocaine, all except seventeen States have placed a similar restriction on the sale of opium and morphine or both, and fourteen States have placed the same ban on chloral hydrate. Since 1912 further important State legislation has been passed.

The use of these drugs by habitués is, however, constantly on the increase, and it is now a recognized fact that only rigid Federal legislation can cope with the situation. A Federal statute passed in 1909 forbids the transportation of cocaine in the mails and prohibits the importation of opium, its preparations and derivatives, except for medicinal purposes.

A Federal statute commonly known as the Harrison Act went into effect on March 1, 1915, which is intended to restrict the use and sale of opium and coca and their preparations and derivatives. By this law every person who is concerned with the handling of these drugs, importing, manufacturing, selling and prescribing, must register with a United States revenue collector and pay a tax of one dollar a year. Even when registered such persons must keep a record of every *sale* of these drugs and give a duplicate to the purchaser. All records must be open for inspection for two years.

A prescription containing any one of these drugs beyond certain limits can be lawfully filled only when it conforms to the following requirements: (1) it must be signed by a physician registered under this Act, giving his name in full, his address and registry number;

(2) it must state the name and address of the person for whom it is prescribed; and (3) it must be dated on the day on which it is signed.

It is unlawful for anyone not registered to have these drugs in their possession except a nurse or other person under the order of a physician who has registered or a person who has obtained the drug by a prescription written as stated above. The penalties for breaking this law are a fine of not more than $2000, imprisonment of not more than five years or both. This Federal Act does not render invalid preëxisting laws which are wider in scope.

Another important recent Federal statute in regard to drugs is the so-called Pure Food and Drugs Act which went into force in January, 1907. This law is aimed especially at adulteration and misbranding of drugs. According to its requirements in regard to adulteration, any drug sold under the name given in the United States Pharmacopœia or the National Formulary must be up to the legal standard or any variation in the standard must be stated truthfully on the label. In regard to misbranding, this law penalizes false statements as to ingredients or place of manufacture, imitation of articles sold under another name, and the substitution of some other preparation for the original contents. It requires a statement on the label of the presence and quantity of the following drugs: alcohol, morphine, opium, cocaine, heroin, alpha- or beta-eucaine, chloroform, cannabis indica, chloral hydrate, acetanilid, and any derivatives or preparations of these drugs.

On the statutes of practically every State and territory of the United States is a list of substances which under the law in that district are considered poisons. This list is frequently in two parts, one including substances the sale of which must be recorded, and the other those which must be labelled "Poison." In most cases the pharmacist is also required by law to question the purchaser as to his knowledge of the nature of the drug and as to his object in buying it. The drugs the sale of which has to be recorded are usually those most often used for suicide or murder: arsenic, the salts of mercury, hydrocyanic acid (prussic acid) and its salts, strychnine, oil of bitter almonds (contains prussic acid), and phenol. The list of drugs which have to be labelled "Poison" includes many which cause corrosion, abortion, or death in overdoses. This list varies very much in different States but nearly always includes aconite, belladonna, digitalis, colchicum, conium, nux vomica, cantharides, croton oil, mineral acids, oxalic acid, white precipitate, cotton root, ergot, savia, and some of the salts of zinc and lead.

A nurse should remember that she comes under the law in purchasing poisonous drugs even if she does have more thorough knowledge of their character and use and must not expect a pharmacist to make himself liable to fine, loss of license, and even imprisonment by selling her drugs illegally. It should be a matter of honor for every nurse to coöperate with the pharmacist in upholding the law.

PART VI.

OTHER THERAPEUTIC MEASURES.

CHAPTER XXVI.

PSYCHOTHERAPY.

Psychotherapy may be defined as any method of treatment by which the condition of the brain can be favorably changed and thereby general physical and mental conditions improved. The method varies with the doctor and with the patient.

As the brain has within its convolutions areas which control every organ and function it can influence conditions in every part of the body. There is no state of the brain which does not in some way affect the body and disease of the body often affects the brain.

When the brain receives at the same time two contrary impressions it reacts to the stronger. For example, when it receives an impression of joy together with one of pain from a diseased organ it will react to the one which is most intense. It is then understood why a sunny room, a cheerful voice, a happy face,

and enjoyable occupation help to lessen suffering. The object in all psychotherapeutic treatment is (1) to occupy the brain with feelings contrary to those in other parts of the body and (2) to increase its control over the bodily functions.

The greatest factors in giving strength to the brain are faith and what has been called by Dr. Cabot "expectant anticipation." A strong belief that a special type of treatment is to be a means of cure actually stimulates the brain and as a result gives tone to the nerves, bloodvessels, heart, and muscles. It matters little what the object of the belief may be: a charm carried in the pocket, an image or relic of a saint, a benediction by some eminent person, a prayer, a prescription, Christian Science, a quack, or some trusted physician. This explains the efficacy of bread pills, placebos, and powders of saccharum lactis, and the importance of confidence in the physician on the part of the patient. Faith is a first essential to the success of any psychotherapeutic treatment.

The methods by which conscious effort is made on the part of the physician to reëstablish control by the brain may be classified as suggestion through the agency of hypnotism, suggestion without hypnotism, and reason.

In **hypnotism** the patient is put into a condition of actual sleep, unlike natural sleep in that he will respond to commands and retain the power to obey them after awakening. While in this state he is given the necessary commands for his recovery. For example, in a case of alcoholism the physician tells the hypnotized

patient that he does not like alcohol and will not want it any more. By this method after one or more treatments the physician himself works the cure, the patient being unconscious and passive. In treatment by **suggestion without hypnotism** the patient is brought to a quiescent state by being subjected to all kinds of soothing influences and while passive but fully conscious is told plainly and emphatically the causes of his troubles, the manner in which they will disappear, and what he must do to help in his recovery. By this method months are usually required of persistent and patient persuasion and argument to reëstablish a normal state of the brain. In this form of treatment the patient must coöperate with the physician. **Reason** alone can be used as a form of treatment with patients who in health have a high degree of intelligence and a strong will-power. In this form of treatment the patient is emphatically and persistently given plain truth in regard to his condition and its causes, and advice along very definite lines as to his cure. He is then left to work out his own cure under guidance.

It is of greatest importance that psychotherapeutic treatments should be accompanied by all kinds of hygienic measures, such as cold baths, exercise, and sleeping in well-ventilated rooms. The duty of the nurse caring for such a case is to see that these measures are systematically carried out. She must keep the patient from brooding over himself, use every means to encourage him, make his prescribed duties as easy as possible, and by every means strengthen his will-power.

Psychotherapy has special application in functional[1] diseases of the nervous system and in alleviating the symptoms of certain organic ones. The conditions most often treated are pain, insomnia, nervous irritability, melancholia, phobias, obsessions,[2] neurasthenia, moral laxity, spasm, nausea, alcoholism, and drug habits.

Music is a most efficient aid to psychotherapy. To most people it is a pleasing mental diversion and it has been proved by experimentation to have a distinct effect on the higher nerve centres varying according to the style of music. Quick martial music is a stimulant, a dreamy nocturne a sedative. Through the ages the value of music as a therapeutic agent has been recognized and there are instances of cures of melancholia by music when all other measures have failed. A professor of experimental psychology in Johns Hopkins University, in an address to a body of nurses, made the statement that every woman who devotes her life to nursing should be able to sing to her patient.

Psychotherapy has been slow in taking a definite place in medicine partly because of its bad reputation from association with quackery. Any person with a little knowledge of this art, a knack in applying it and an insight into human nature can practice quack-

[1] In a functional disease the tissues of an organ are intact but the nerve control is lost.

[2] A mental disorder in which a person is controlled by some strange idea or fear. An example is a case of a woman who was afraid she would walk in her sleep and could not sleep unless she were tied securely to the bed. She was cured by mental treatments.

ery and undoubtedly perform some cures. It is estimated that in New York City there are 20,000 quacks to 6000 registered physicians. The appalling side of quackery is that it attempts to cure every ailment regardless of its cause and that every applicant is made to feel that he has some serious disease which can be cured on payment of a correspondingly large fee.

CHAPTER XXVII.

HYDROTHERAPY.

Hydrotherapy is the art of treating disease by means of water. Hydriatric is an adjective in common use as a substitute for hydrotherapeutic.

The father of modern hydrotherapy is Dr. Wilhelm Winternitz, now an old man, professor emeritus of the University of Vienna. Dr. Simon Baruch, the highest authority and leading advocate of water as a therapeutic agent in the United States, pays him tribute by stating that to him medical science owes nearly all it knows about the scientific use of water. Besides his work in original research he was a great teacher, wrote two hundred books and monographs, and created the first hydrotherapeutic clinic in Vienna at his own expense. In spite of his efforts little attention was given to this form of treatment until a quack, Father Kneipp, a Bavarian priest, established a water cure which became so popular that regular medical practice was seriously affected financially. Steps were then taken to give hydrotherapy a place in medical schools and clinics in Austria and Germany. Largely through the efforts of Dr. Baruch in this country the value of hydrotherapy has become well recognized here, and definite principles of method and dosage have been worked out.

The conditions in which water is a useful therapeutic agent are almost unlimited because it may be used as ice, water or steam; it may be given internally, hot or cold; and applied externally, hot or cold, in baths, packs, stupes, douches, all kinds of sprays, irrigations, and in bags and coils. It may serve, according to the method of application, as a nerve sedative or stimulant, a heart stimulant, a means of altering the circulation, a stimulant to the skin, a diaphoretic, a laxative, a hemostatic, a counter-irritant, and a general tonic.

Internal Use.—The value of water internally is generally recognized as a food, a cathartic, a diuretic, and a diluent. It is quite possible, however, to drink too much water. Large quantities of hot water taken over a long period cause dilatation of the gastro-intestinal tract; excessive amounts of cold water over a long period may cause a general edema.

External Use.—The external application of water at or near the temperature of the skin (about 90° F.) produces no effect. All therapeutic action depends on the *difference* in the temperature of the water and the skin and varies directly with the amount of difference. When water is mentioned as a therapeutic agent it is assumed to be sufficiently hot or cold to produce some effect.

Action.—Cold, heat, and an impact against the skin are all irritants to the sensory nerve endings of the skin. By reflex action the nerve centres are stimulated and a general improvement follows in the organs and tissues of the body. These same factors, especially

cold, cause the capillaries to contract, sending more blood to the large arteries, and increasing the force of the heart. When the cold or other cause is removed the capillaries dilate, they are then rapidly filled with blood, and a redness or glow of the skin results. This is known as the "reaction" and is proof of the restoration of an active circulation.

Factors which Determine Action.—In general the degree of stimulation and of reaction vary directly with (1) the temperature of the application; (2) its duration; (3) the extent of surface treated; (4) the force of the impact; (5) the susceptibility of the patient; (6) the amount of friction during and after the treatment.

1. *Temperature.*—The following shows the effect in general of the varying temperatures:[1]

Bath.	Temperature.	Effect.
Cold	40°– 65° F. (4.4°–18.3° C.)	Overstimulation followed by fatigue or even collapse. Hemostatic.
Cool	65°– 75° F. (18.3°–23.8° C.)	Stimulation.
Tepid	85°– 95° F. (29.4°–35.0° C.)	Stimulation.
Warm	95°–100° F. (35.0°–37.7° C.)	Sedative.
Hot	100°–110° F. (37.7°–43.3° C.)	Stimulation.
Very hot	110°–120° F. (43.3°–48.8° C.)	Hemostatic.

2. *Duration.*—A cleansing or stimulating bath should not last more than three to five minutes. In health a regular practice of prolonged baths or of bathing more than once a day tends to be debilitating and may cause nervousness and loss of weight. The effect of a continuous hot bath (about 100° F.) without

[1] Temperatures from Hinsdale's Hydrotherapy.

friction is to reduce the blood supply of the brain and sooth the nerves. This form of treatment is much used to relieve insomnia and to quiet the insane. For insomnia a bath of ten to thirty minutes may be prescribed; in the case of the insane it may be continued from one or two to twenty-four hours.

3. *Extent of Surface.*—When cold water or ice is continuously applied over a small area, as in a bag or coil, it is usually for the purpose of contracting the bloodvessels at the point of application to reduce an inflammation or to check hemorrhage. The purpose of a cold compress is the same as that of a cold bath or pack confined to a limited area; that is, to get a vigorous reaction at that point in the superficial bloodvessels and thus relieve a deeper congestion. As the purpose of cold compresses is to increase *heat loss* they should never be covered with oiled or rubber cloth which are non-conductors of heat. Hot local applications dilate the capillaries and likewise act as a counter-irritant. Local treatments of this kind may produce some change in the force or rate of the heart beat but for general stimulation half or full immersion or spray baths are used.

In regard to the last three factors named above, it is commonly known that an *increase* in the **force of the impact** of the water, the **susceptibility of the patient,** and the **amount of friction** will produce correspondingly greater stimulation and better reaction.

Cold Baths.—The purpose of cold baths in any form is stimulation. Their use in fevers is to increase the patient's power of resistance by stimulating the nerves

and heart—only incidentally to reduce the temperature. The regulation of the temperature of the water and the use of friction are most important in such cases for

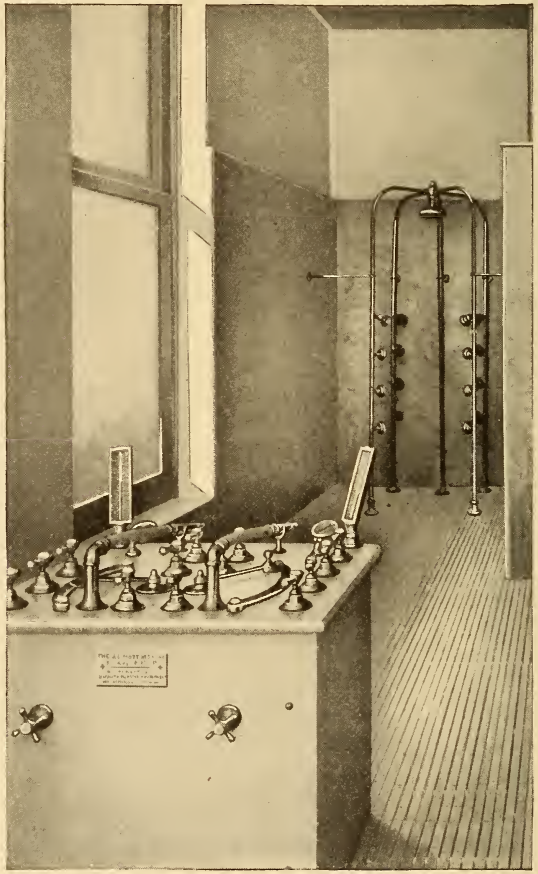


FIG. 21.—Portion of douche room, Michael Reese Hospital, Chicago, showing control table of Mott type (foreground) and combination douche (background) where the patient stands during treatment.

without a good reaction the baths are a distinct harm. It is also essential that the patient be thoroughly warm before the bath, that the bath be given in a warm room, and, in the case of bed patients, that ice cloths or an ice-bag be kept on the head. Cold baths are given (1) to bed patients in the form of sponge baths, slush baths, and wet packs; (2) in tubs by pouring water from pitchers over the patient while standing or sitting in water or by drip sheets; and (3) by various kinds of douches, jets, and showers directed from a control table. This control table is so constructed that the operator can regulate the form, direction, temperature, and force of the water. Some of the common forms used are the jet douche, a small stream under pressure; the Scotch douche, alternating hot and cold; the rain douche, a stream from above; a fan douche, produced by placing the finger over the nozzle of a jet; and a circular douche, in which the water strikes at an angle and the patient turns slowly around. Usually as a preliminary to douche treatments the patient is placed in a hot-air or electric-light cabinet to get him thoroughly warm. A typical prescription for hydrotherapeutic treatment is given in full. In practice abbreviations are used.

Hot-air baths: until perspiration starts.
Circular douche: 2 min., 105°–90° F. (40.6°–32° C.), 20 lbs.
Jet douche: 1 min., 100°–80° F. (37.8°–26.7° C.), 20 lbs.
Scotch douche: 20 sec., 105° and 80° F. (40.6° and 26.7° C.), 20 lbs.
Fan douche: 10 sec. at 78° F. (25.6° C.).
Alcohol rub. Reduce minima 1° daily to 60° F. (15.6° C.).

Such treatments are used as general tonics in anemia, nervous disorders, general debility and in weakening diseases like tuberculosis.

Balneology.—Balneology is a term applied to the use of mineral waters in disease. Mineral waters have a wide reputation both for internal and external use. When taken internally they have the same action as the mineral ingredients which they contain. For example, chalybeate waters (those containing iron) are useful in anemias, arsenical waters for scrofula and anemia, alkaline waters for rheumatism and gout, sulphur waters for skin and liver diseases, bromo-iodin waters for skin diseases and goitre, saline waters as cathartics. It is now an established fact that these waters in the form of baths have no more systemic action than plain water with the exception of those which are strongly saline and effervescent. Strongly saline water and carbon dioxide gas are irritating to the skin and by reflex action cause some general stimulation. A strong saline bath is called a brine bath; a strongly effervescent one, a sprudel bath. Some of the mineral waters are undoubtedly radio-active and are thus more stimulating. The change, rest, diet, diversion and routine life of a spring resort are large factors in the recovery of a patient. At the more famous resorts are doctors who have become very skilful in combining the various hydrotherapeutic treatments with other hygienic measures so that the maximum benefit is derived from both.

In the United States there are 2800 spring localities and about 9000 individual springs. The most important resorts are at Hot Springs, Arkansas; Hot Springs, Virginia; Saratoga and Richfield Springs, New York;

Mt. Clemens, Michigan; and French Lick and West Baden, Indiana. The best-known foreign resorts are Nauheim, Baden-baden, Aix-la-Chapelle and Hamburg in Germany; Carlsbad in Austria; Bath and Buxton in England; Aix-la-Bains in France; and Helouan-les-Bains in Egypt. Some of the resorts specialize in certain diseases, as, for example, Nauheim in heart diseases, Buxton in gout, West Baden, Indiana, in alcoholism and cases of drug habit, and various hot spring resorts in rheumatism. Syphilitic cases are treated at certain springs, the baths enabling the patient to bear excessive mercurial medication. The value of Nauheim baths in heart cases is to a great extent due to carefully prescribed gymnastic exercises. Concentrated salts are exported from Nauheim and other springs for use in making artificial baths.

Other Baths.—A new form of bath is one in which the water is charged with oxygen, little bubbles of which gather all over the patient's body. The action is to reduce a high blood-pressure and a high rate of respiration and pulse.

A Turkish bath consists of a hot-air bath, until there is free perspiration, followed by massage and, lastly, a cold plunge and swim. This is beneficial in gout, dyspepsia, obesity, and alcoholism.

A Russian bath accomplishes the same result by means of a hot-steam bath followed by a cold plunge.

Baths in mud, peat, and fango (volcanic mud) are beneficial simply as a method of applying heat, and are used in rheumatism, gout, arthritis, and neuralgias.

CHAPTER XXVIII.

ELECTROTHERAPY.

ELECTROTHERAPY is the use of electricity as a therapeutic agent. The action of electricity when applied to living tissues is to cause general stimulation or depression, to produce heat, and to bring about chemical changes in the cells. These chemical changes may be any one of three distinct kinds; a rearrangement of ions,[1] a displacement of ions, or the introduction of new ions from outside.

There are three types of machines in common use for the generation of electricity and their respective currents have distinctive characteristics and special uses in medicine. They are known as static, galvanic, and faradic according to the method of generation.

Static Electricity.—Static machines generate electricity by the revolution of a series of disks, alternate disks revolving in opposite directions (Fig. 22).

For treatment by static electricity the patient is placed on an insulated stool, that is, one so made that a current of electricity cannot pass from it to the floor.

[1] It is generally held by chemists that certain substances when in solution dissociate into their constituents—either elements or radicals. Each of these constituents, being electrically charged, is termed an ion. Ions are either negative or positive according to the charge that the carry.

In local treatments the affected part is sometimes exposed but ordinarily the patient may be fully dressed.

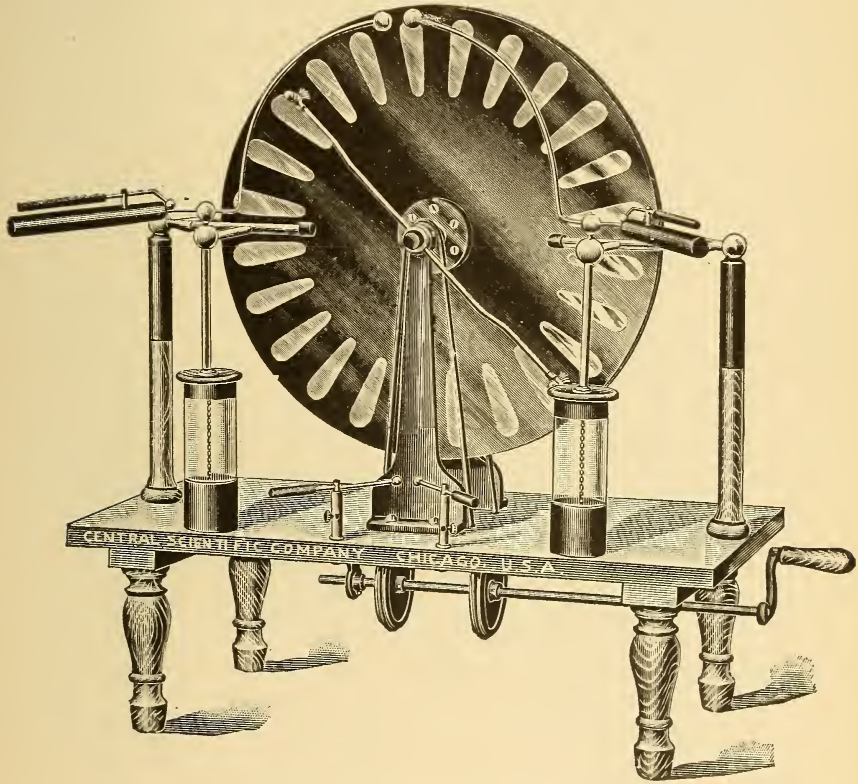


Fig. 22.—Wimshurst machine. (Potts.)

The current is carried to him from the machine by means of chains or insulated wires. One electrode[1] is

[1] An electrode is here understood to mean the part of the apparatus which comes in contact with the patient. By means of the two electrodes the patient becomes a part of the circuit through which the current of electricity passes.

placed in the patient's hand or under his feet and the other on some other part of the body.

If while the patient is subjected to the current a third electrode is held near him a sensation is felt like a breeze from that electrode. This is called an electric breeze or brush discharge and it is used as a sedative to painful superficial nerves and certain itching skin diseases and as a stimulant to chronic ulcers and certain chronic skin diseases.

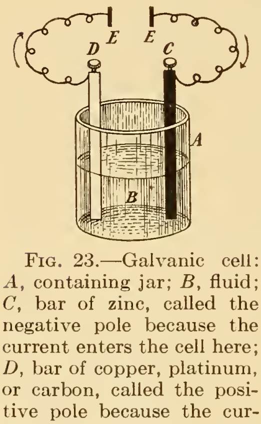


Fig. 23.—Galvanic cell: *A*, containing jar; *B*, fluid; *C*, bar of zinc, called the negative pole because the current enters the cell here; *D*, bar of copper, platinum, or carbon, called the positive pole because the current leaves the cell at this end; *E*, the ends which would be applied to the patient. Dry cells are made by substituting a damp chemical powder for the fluid and are now much used.

If this third electrode be held quite near, sparks will pass from it to the patient which cause muscular contraction at the point of contact. The effect produced depends upon the size of the spark, small ones acting as a sedative, large ones causing severe contractions of the muscles and invigoration.

Galvanic Electricity — Galvanic electricity is generated by a galvanic cell (Fig. 23). One cell does not produce enough electricity to affect the human body, so a series of cells, from 20 to 30, are connected forming a galvanic battery (Fig. 24). The strength of the current is regulated by the number of cells.

The electrodes of a galvanic battery are always

padded to avoid burns and when in use they are kept wet with sodium bicarbonate or chloride. The skin is also kept wet, but even then it must be watched to avoid blisters. One electrode is placed over the affected part; the other at the back, abdomen, feet, or hands so that the two are a long way apart. For treatment of the whole body, galvanic electricity may

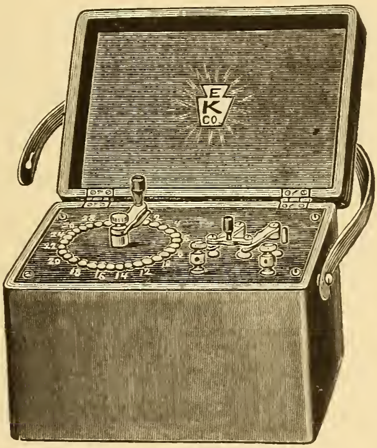


FIG. 24.—Keystone portable galvanic battery. (Potts.)

be given in an electric bath, that is, the patient or one or more of his extremities are fully immersed in warm water and electricity is conducted into the water.

Faradic Electricity.—Faradic electricity, named from its discoverer, Prof. Faraday, is generated by what is called an induction coil (Fig. 25). An induction coil is a reel of insulated copper wire containing an iron core and a second reel of wire over the first, separated

from it by hard rubber. A current of electricity from a galvanic battery is passed through the reels of copper wire. By it the iron core temporarily magnetizes them and the original current is transformed to one especially adapted to medical treatment, that is, it has a high degree of activity to a comparatively small amount of current and has a high degree of penetration.

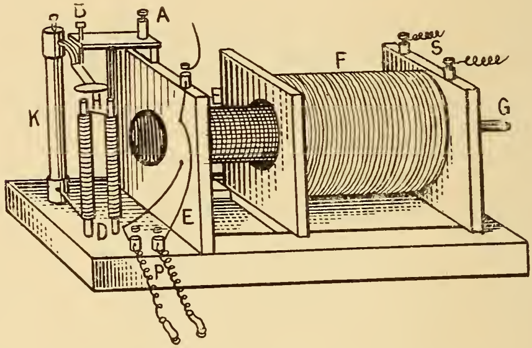


Fig. 25.—Induction coil: *E*, primary coil; *F*, secondary coil slid to the right to show the primary coil; *P*, wires conveying current to the patient from the primary coil; *S*, from the secondary coil; *G*, the end of the iron core. To the left of the coils is apparatus which makes and breaks the current on the way to the patient. (Sturridge.)

The two reels are not used at the same time. The inner one produces what is called the primary current, the outer one the secondary current. The first is used especially for treatment of deep-seated organs; for example, the intestines in chronic constipation. The secondary current is of special use in treatment of the limbs and the skin.

Faradic treatment is conducted in the same manner

as galvanic except that the pads are wet in tepid water alone. It is very frequently given in the form of full immersion baths.

Types of Electrical Currents.—The currents of electricity obtained from these machines are of three distinct types: continuous, interrupted, and alternating. They are expressed graphically below (Fig. 26).

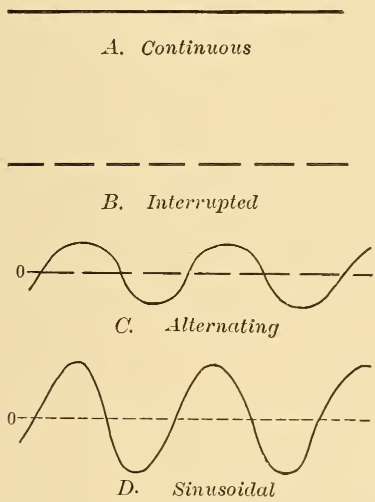


Fig. 26.—Graphs of types of electric currents.

A continuous current may be compared to a steady flow of water which does not vary in force. An interrupted or intermittent current is made from other kinds by special apparatus which at regular intervals makes and breaks the original current. An alternating current is one which varies periodically both in force

(*B*) and direction (*C*). The sinusoidal current is a special type of an alternating current which has a high degree of penetration. The frequency of a current means the number of waves per second. A low-frequency current has a small number, a high frequency several thousand.

The choice of current for treatment of different diseases varies very much with the operator. Muscular contractions are caused by an interrupted current, one of low frequency, and by a sudden increase or decrease in the force of a current. Such an action is desired in diagnosis to determine the origin and degree of a paralysis and as a therapeutic agent to restore an atrophied or weak muscle by mechanical exercise. Continuous and high-frequency currents are commonly used to stimulate the nervous system and to increase metabolism and elimination. Some of the conditions in which good results have been obtained are neurasthenia, neuralgia, anemia, general debility, paralysis, chronic rheumatism, and phthisis. High-frequency currents are often used in connection with *x*-ray treatments in gynecology to promote the absorption of exudates and abnormal growths. They are in some cases employed purely for their heat effect. This form of treatment is called diathermy and is employed in headaches, neuralgia, rheumatism, locomotor ataxia, tic douloureux, deafness, eye affections, and as a caustic.

Electricity may be employed by means of needles to remove birth-marks and other blemishes. In cases of obesity its use is based on the theory that the

muscular contractions caused by the currents take the place of excessive exercise for those who because of a weak heart cannot endure normal physical exercise or a reduced diet.

Most electrical treatments last from ten to fifteen minutes and are repeated two or three times a week.

Cataphoresis.—A more recent use of electricity in medicine is to introduce drugs into the body through the skin. This is called cataphoresis or ionic medication. By this method the drugs probably are introduced directly into the cells and do not enter the circulation. The procedure is to place over the affected part pads saturated with a solution containing the desired ion and place the electrode over the pad. The choice of electrodes is very important because the different poles cause different ions to enter the body. Examples of ions used in this way are zinc ions for ulcers and fistulas, quinine and salicylic acid for rheumatism, iodine and lithium in gout, chlorine to soften scar tissue, and cocaine for local anesthesia. Electric baths have been tried with some success in cases of lead poisoning in an attempt to promote excretion of the lead ions from the body.

Administration of electrical treatments requires a highly specialized training by both the doctor and the nurse who assists him. A nurse who intends to enter this field must acquire a good understanding of the science of electricity and of electrical machines. To win success she must be thorough, exact, and accurate in her work, capable of careful and maintained attention, and not easily excitable.

CHAPTER XXIX.

SERUMS AND VACCINES.

A THERAPEUTIC serum is blood serum either in its normal state or one which contains immune substances. The use of *normal* serum as a hemostatic has already been discussed (page 162).

Preparation.—An **immune serum** contains large quantities of protective antibodies against some pathogenic bacterium. It is given to a patient infected by that same bacterium to supplement his own antibodies. This process is called passive immunization. All immune serums are prepared by inoculating some animal with the microörganism against which immunity is desired until the animal's blood contains the *maximal* amount of antibodies. This is then withdrawn and its serum prepared for therapeutic use.

A **vaccine** is an emulsion of dead or attenuated bacteria in normal saline solution. The bacteria are cultivated on living tissue or in some culture medium. The action of a vaccine as a therapeutic agent is to stimulate the human organism to manufacture its own antibodies. This is known as active immunization.

Therapeutic Use.—In general it may be stated that *vaccines* are of special use for prophylactic purposes and as cures in infections *which tend to become chronic,*

such as gonorrheal infections, infections of the bones, joints and sinuses, and chronic inflammation of the ear. Serums are of greatest value in acute diseases when there is not time for the body to manufacture a sufficient quantity of its own protective antibodies. Some are also efficacious as prophylactics.

Administration.—With the exception of smallpox vaccine, vaccines and serums are given by hypodermic injection into various portions and tissues of the body. The procedure is the same as in any hypodermic injection except that the skin is usually sterilized by painting with tincture of iodine before the injection.

ACTIVE IMMUNIZATION FOR PROPHYLAXIS.

1. **Smallpox Vaccine.**—The method by which this vaccine is introduced is well known. Usually one vaccination is sufficient to produce immunity for a period of at least seven years but in case of an epidemic revaccination is advisable if more than a year has elapsed.

2. **Rabies Vaccine.**—This vaccine is an emulsion in water of a piece of the medulla of a rabbit which died of rabies. It is usually injected into the abdomen daily for about six or eight days. Vaccine of increasing virility is used on the successive days. Immunity lasts only a few weeks.

3. **Typhoid Vaccine.**—Usually three injections are given about a week apart. Immunity lasts from one to three years.

ACTIVE IMMUNIZATION AS A CURE.

Attempts to use the before-mentioned vaccines as cures have not met with any degree of success. The most commonly known vaccine used in an attempt to cure is Koch's Old Tuberculin and Neu (new) Tuberculin for tuberculosis. The first has now been practically discarded. The results obtained from the last are extremely variable and its use at best is limited because of the difficulty in regulating the dose to avoid its toxic actions. The best results have been secured in institutions where the patient can be thoroughly studied and kept under control.

PASSIVE IMMUNIZATION.

1. **Diphtheria Antitoxin.**—This is a horse serum containing the antibody antitoxin, which neutralizes the toxin excreted by the Klebs-Löffler bacillus just as an alkali neutralizes an acid. It is given every twelve to twenty-four hours until acute symptoms subside, and an early injection will practically abort these symptoms. In extreme cases it may be given intravenously. This serum has been standardized so that a unit is a quantity capable of neutralizing 100 units of toxin.[1] The average curative dose is 3000 units, for prophylactic purposes 500–1000 units.

2. **Tetanus Antitoxin.**—This serum has been proved most efficacious as a prophylactic but until very recently has been regarded of little or no value after

[1] A unit of toxin is the amount required to kill a 250-gramme guinea-pig in 4 to 5 days.

the tetanic symptoms have appeared. From recent research this failure seemed to be due to a wrong method of injection and to the use of too small doses. The tetanus microörganism multiplies in the infected wound and liberates toxins which enter the circulation but to a larger extent pass along the nerve trunks to the spinal cord where they accumulate in large amounts. When the antitoxin is given subcutaneously its action is very slow in the circulation and it cannot readily reach the toxins along the nerves or in the cord. For prophylaxis this method may be successful in slowly developing cases but as a cure it is a failure. Two experimenters, Park and Irons, have recently concluded that for curative purposes the antitoxin must be administered intraspinally, intravenously, or by both channels at once. Intraspinal injections are usually given under an anesthetic. Tetanus antitoxin has been standardized by the United States government, but no definite dosage has yet been established. For prophylactic purposes about 3000 units are given subcutaneously. After tetanic symptoms have begun the experimenters mentioned above advise as a curative dose, 3000–5000 units intraspinally and 10,000–20,000 units intravenously at the same time, a second intraspinal dose after twenty-four hours, and after four or five days, 10,000–15,000 units subcutaneously to maintain the protection for several days longer. Immunity lasts at most only a few weeks.

3. **Meningitis Antiserum.**—The popularization and perfection of this important serum is the result of work by Dr. Simon Flexner of New York. It contains

various antibodies, agglutinins, precipitins, bacteriolysins, and others, and their action is to check the multiplication of the meningitis organisms and to increase the activity of the phagocytes. They are injected intraspinally as a means of cure.

OTHER SERUMS AND VACCINES.

There are many remedies of this type which are still in the experimental stage or which are not in very general use. Good results have been obtained from cholera and plague vaccines and from antivenene, a prophylactic serum against poisoning from venomous snake bites. The last is regularly used in military hospitals in India and is efficient if injected within eighty to ninety minutes after the bite. Reports from the use of antipneumococcus, antigonorrheal, anti-whooping-cough, antidysentery, and antistreptococcus serums show varying results. The last has been used in scarlatina, erysipelas, septicemia, and streptococcus infections of the nose and throat.

There are several preparations on the market called **phylacogens** for rheumatism, gonorrhea, erysipelas, pneumonia, and one for mixed infections. They are highly toxic mixtures of the products of the metabolism of certain pathogenic bacteria. They have not yet been endorsed by the medical profession.

There are many failures in the use of serums and vaccines which are variously explained. The preparation may be poor; with only three exceptions there is no standard by which the dosage can be

regulated; and the serum may be injected where it cannot readily and promptly reach the infection. Another reason for failure is that all vaccines and serums are specific in action against some one microorganism and it may not be known what microörganism is present in the individual case. For example, pneumonia may be caused by more than one form of pneumococcus, and for successful treatment the particular one present in any individual case must be determined and a serum against that one must be used. In the present state of serum and vaccine therapy this is not always possible. To overcome this difficulty **stock vaccines** are made containing a number of different strains of pathogenic bacteria, true "shotgun" remedies. Such a vaccine has been recommended to produce immunity against common head colds. To secure specific action vaccines called **autogenous vaccines** are made from cultures taken from the blood, sputum, urine or pus of the infected patient. This is probably the only rational method.

SERUM SICKNESS.

Often following the administration of serum a reaction occurs, that is, certain symptoms arise that are caused by the serum, such as fever, headache, edema, asthmatic conditions, and even collapse. This reaction is now known to be an example of anaphylaxis. *Anaphylaxis* is defined as the phenomenon following the introduction of a soluble protein (by means other than through natural channels) into the circulation of

an animal previously sensitized to this protein. The method by which a person becomes sensitized is not always known. Anaphylaxis may lead to serious results and as a precaution a physician may inject very small amounts of the serum at first to determine to what extent a patient may be sensitized or to create an anti-anaphylactic state. Previous serum treatments, asthma, hay fever, and an idiosyncrasy to the exhalations of horses are conditions which indicate the need of care in giving a serum. A state of hypersensitiveness may last for seven years.

In 1902 a Federal law was enacted under which the Public Health Bureau of the United States government supervises the manufacture and interstate sale of vaccines, serums, and other biological products. The government license certifies approval of the technique of the process, the sanitary conditions of the laboratories, and the care of the animals, and requires certain facts printed on the label of the products, but it is not a guarantee of therapeutic worth. The government has no control over worthless products except as imports or in interstate sales. Smallpox vaccine and diphtheria and tetanus antitoxins are standardized, and antirabic serum has recently been distributed from Washington for treatment outside of the Pasteur Institutes.

CHAPTER XXX.

RAY THERAPY.

The scientific use of various kinds of rays in the treatment of disease has recently come to form a distinct branch of therapeutics. Some of the terms in common use to designate special forms of ray therapy are: heliotherapy, the use of the sun's rays; chromotherapy, the use of colored light; Röntgen-therapy, the use of x-rays or Röntgen rays; and radiotherapy, the use of various kinds of rays.

HELIOTHERAPY.

It is not difficult to understand why the sun was worshipped as the source of life by primitive peoples because it was and is a matter of common observation that vegetable and animal life wilt in the dark and thrive in the sun. It is only within the last twenty years, however, that efforts have been made to develop a systematic method of using the sun as a therapeutic agent and to separate the different kinds of rays in sunlight for special uses.

The first series of observations as to the effect of sunlight on disease was made by Dr. Loncet of Lyons, France, about 1890–1900, in cases of tubercular affections of the joints. He obtained excellent results, some

of which were almost miraculous, and became convinced that the benefit extended also to the internal organs. In 1911 Dr. Rollier, a Swiss physician, followed Dr. Poncet's method under very different climatic conditions with equally good results.

Strong sunlight is an irritant to the skin drawing the blood to the surface. It is bactericidal, it causes an increase in the number of red corpuscles and in the hemoglobin in the blood, and it may by reflex action stimulate the internal organs. Whatever the method of action, it is a fact that exposure of the naked skin to the sun is a valuable and easily available therapeutic agent in anemias, general debility, acute muscular rheumatism, and especially in all forms of external tuberculosis. This, like any other remedy, should be used systematically and should be taken under advice, as too great exposure causes loss of weight, nervousness, and other bad results.

The physical phenomenon known as light is a sensation caused by the movements of ether waves on the organs of sight. These waves are of varying length, and the length of the wave determines the color of the object from which it comes to our eyes. Short waves produce a violet color, long waves a red color, and between these two are all the elementary colors. When waves of all lengths are mixed together the sensation on our eyes is white or absence of color. If a beam of light passes through certain substances, such as a drop of water or a prism, the individual rays are refracted (bent) at different angles and thus may be divided into the different colors according to the

length of their waves. This is the way a rainbow is formed and may be diagrammed as in Fig. 27. This is called the spectrum of light.

There are more rays on each side of the spectrum which under ordinary conditions are invisible. Those beyond the red are called the infra- or ultra-red rays or heat rays because they have the property of emitting heat. Those beyond the violet are called the ultra-violet, actinic or chemical rays as they

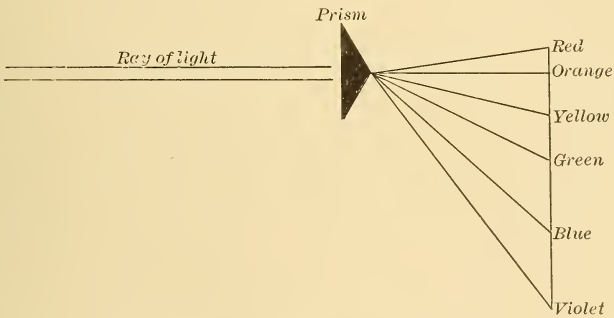


Fig. 27.—Diagram of the spectrum of light.

have the property of affecting a photographic plate and of causing chemical changes in living tissues.

Red glass is impermeable to ultra-violet rays and for this reason light admitted into a photographer's dark-room through red glass does not affect undeveloped plates. This also explains the custom among certain primitive peoples of keeping smallpox patients in a room provided with red glass windows or of covering the face with red cloth to prevent deep

pitting. It is now known that this is a rational procedure because by this means the irritating ultra-violet rays are screened from the sores. On this principle rooms with red glass windows have also been tried for cases of scarlet fever and measles with some success.

Ultra-violet rays are in some cases desirable. They stimulate healing in chronic ulcers and as they are sufficiently active to be bactericidal they are used in treatments of lupus, eczema, and superficial malignant tumors and also for the purpose of sterilizing water.

The electric arc light and the mercury vapor light (commonly seen in the popular night photo studios) are particularly rich in ultra-violet rays but any light may be used as a source by filtering out the red rays. Finsen, a Swedish physician, who is a strong advocate of light as a therapeutic agent, uses chiefly a powerful electric arc light. An apparatus used in medicine to obtain large amounts of ultra-violet rays is the condenser spark lamp, in which the light is generated by electric sparks and the red rays are filtered out by a special lens.

Electric-light cabinets are, as a rule, equipped with incandescent lights in which the heat rays predominate and are lined with mirrors or some highly polished metal for the purpose of reflecting the rays toward the inside of the cabinet. They are commonly used to produce sweating in such cases as chronic rheumatism. A portable electric-light bath has been devised for bedside use as a diaphoretic measure fully as efficient as a hot pack and much more agreeable to the patient.

RÖNTGENTHERAPY.

The elaborate equipment of an x-ray room is simply a means of providing an electric current for passage through a vacuum tube. In this way invisible rays called x- or Röntgen rays are produced. Modern vacuum tubes are modifications of the original vacuum tube used by Crookes, an English scientist, who first discovered in 1879 that rays are generated by this apparatus. Because they came from the cathode end

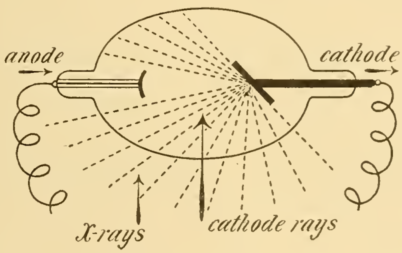


Fig. 28.—Diagram showing principles of x-ray tubes.

of the tube he called them cathode rays. Fig. 28 illustrates the principles of all vacuum tubes in x-ray work, Fig. 29 shows one type of a modern x-ray tube. There are various devices in the new tubes for the purpose of maintaining a constant vacuum and automatically regulating the current. These tubes are very brittle and very expensive.

Sixteen years after Crookes's discovery Prof. Röntgen, of Germany, found other rays projected from the cathode rays (Fig. 28) which were very penetrating and which would photograph invisible objects, such

as the bones in the human body and coins in a purse. He modestly named these new rays, x-rays, but others called them the Röntgen rays from their discoverer whose name should rightly be associated with this agent which has come to be so important in modern medicine.

The principle of x-ray photography is the varying resistance of the different tissues of the body to the passage of the rays. For example, the bones are very resistant, hence the plate in that area is unaffected;

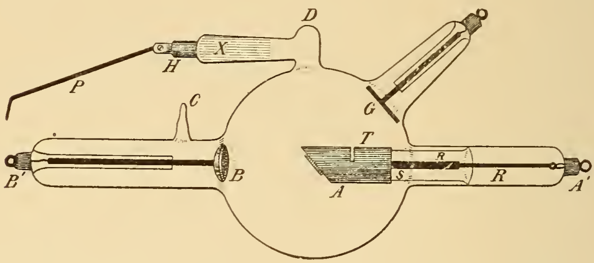


Fig. 29.—Diagram illustrating the construction of a modern type of x-ray tube of American manufacture. (Potts.)

the kidney is somewhat resistant, hence in that area the plate is slightly shadowed. x-rays themselves vary in their power of penetrating the tissues according to the degree of vacuum in the tube, the less penetrating rays being known as soft rays and the more penetrating as the hard rays.

x-ray photography is today an invaluable means of diagnosis of certain conditions. By means of the plates foreign objects such as bullets, needles, and calculi can be located; fractures, deformities, and

lesions of the bones and the condition of certain organs can be detected; and by introducing into the alimentary canal some substance which adheres to the mucous membrane and which does not transmit the *x*-rays, the location and size of the canal can be seen. Apparatus has been devised by which a number of photographs can be taken in a minute so that the movements of the alimentary canal can be studied, and attempts are now being made to perfect a moving picture *x*-ray machine. The interpretation of an *x*-ray plate is of greatest importance and requires the skill of an expert.

When *x*-ray photographs are to be made of any part of the alimentary canal or of the kidney region the alimentary canal must be thoroughly emptied as it is before an operation. The substances commonly administered for the purpose of outlining the alimentary canal are bismuth subcarbonate, oxide or oxychloride and barium sulphate. Several hours before the picture is to be taken about two ounces of one of these substances are given by mouth or rectum (according to the part to be photographed) in some thick, pasty food such as cereal, buttermilk, or thick soup. Before photographing the urinary organs a solution of a silver salt may be injected into the bladder or ureters.

It is now known that an *x*-ray apparatus generates rays similar to, if not identical with, gamma rays, a type of rays given off by radium and radio-active metals which are of greatest therapeutic value. This explains the fact that treatment by *x*-rays or by radium

may give equally good results in similar affections. Various skin diseases, small tumors, tubercular glands, chronic ulcers and leukemia are treated by the x-rays and its effects are almost specific in epithelioma and tubercular adenitis. The same apparatus is used for treatment as for photography with lower currents and longer exposures. The rays are confined to the area to be treated by means of lead cylinders and their activity is regulated by screens, usually of aluminium.

There is no way for a nurse to learn to assist in x-ray work except by experience. This field offers an opportunity for a nurse to become expert in a specialized and important line of work but it is trying on the health because of the long periods of time which have to be spent in the dark-room.

RADIUM.

The discovery of radium and radio-activity was a direct result of experimentation with the x-rays. Becquerel, a French scientist, first discovered that certain natural substances such as the metal uranium have the property of giving off streams of tiny atoms at a great velocity, these streams being similar to rays of light which are waves of ether. Such substances are said to be radio-active.

Shortly after Becquerel's discovery M. and Mme. Curié of France commenced their study of ores which contained uranium. They found that some of the ores were more radio-active than uranium itself and therefore must contain some unknown element. By a most

laborious process, every step of which involved original research, they isolated in 1898 three new substances, one of which was radium chloride. Mme. Curié later obtained pure radium which is usually used in medicine in the form of the bromide, a brown, rather finely divided powder.

Radium and its salts give off three different kinds of rays, the alpha (α), beta (β), and gamma (γ). They are separated from one another in practice by inter-

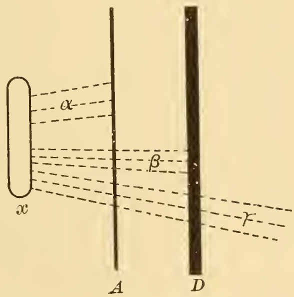


FIG. 30.—Varying penetrability of radium rays: *x*, tube of radium bromide; *A*, piece of paper; *D*, sheet of lead.

posing screens which are penetrable by one kind and not by the others. A piece of paper will filter off the alpha rays, and a thin sheet of lead the beta, leaving the gamma rays. The separation in practice is never as complete as is indicated in Fig. 30.

Alpha rays have little power of penetration. They are absorbed by the skin and as tissues are affected only by the rays which are absorbed by them, not by those which pass through, they are probably responsible

for the effect of radium rays on the skin. Beta rays are much more penetrating than the alpha, more numerous, and probably have some curative power. Gamma rays have a very great power of penetrability, some of them being able to pass through every part of the human body. They are comparatively few in number but at the present time they are credited with the beneficial effects of radium on pathological tissues.

The exact nature of the action of radium on living tissue is not known. A few days after the application of unscreened radium rays on healthy skin redness and tenderness appears and a scab may form which, on peeling, leaves a fresh, soft skin. If a very strong radiation is given a suppurating ulcer will form which readily heals. In tumors the newly formed cells either disintegrate or atrophy; in cancers the cancerous tissue is partly destroyed and partly inhibited in growth. Radium has proved especially useful in a serious form of ulcer called rodent ulcer. Its use has met with much success in treatment of warty growths, swollen, malignant, and tubercular glands, malignant growths, lupus, keloids, fibroid tumors of the uterus, uterine hemorrhages, and corneal ulcers. In cases which are not cured it lessens pain, checks suppuration, removes foul odors, and practically always causes some retrogression.

Radium is kept in sealed glass tubes which are frequently enclosed in gold, silver or platinum for protection and as a filter for the alpha rays. These tubes are about one-quarter of an inch in diameter, three-quarters to two inches in length, and contain

from 80–120 mg. of the bromide according to their size. They may be imbedded in a tumor or cancer, inserted into the various openings of the body, such as the rectum or vagina, placed directly on the skin over the affected part, or held some distance away from the part that the radiation may spread over a larger area. For strong radiation a tube may be used without screening but often sheets of lead are placed between the tube and the surface being treated to filter out all except the gamma rays. The factors which determine the dosage of radium rays are the amount of radium, the degree of screening, the distance away from the part treated, and the duration of the exposure. An exposure may last from one-half hour to several hours.

Treatments by radium and the x-rays are frequently combined. For example a tube of radium may be imbedded in a tumor and external radiation given by the x-rays. The initial expense of radium is great but a tube can be used repeatedly over an indefinite period without any apparent loss of radio-activity. The advantages of radium over the x-rays are the absence of elaborate equipment, the ease with which it can be transported to the bedside, the fact that it can be applied directly within the tissues, and the accuracy with which a dose can be measured. In certain cases radium produces better results, in others the x-rays, and sometimes either may be used with equally good results.

Thorium and mesothorium, two less expensive radio-active metals, are being used to some extent in

place of radium. Emanation, a product of radium, also has some use. Emanation is a gas which is given off from radium and is easily collected from the surface of a solution of a radium salt. It is more radio-active than radium but its activity lasts only a few days against 2500 years in the case of radium. It is used in sealed tubes in the same way as radium, by inhalation for inflammatory conditions of the respiratory tract, and in solution in water as internal medicine or in baths for rheumatism and disorders of the nerves.

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